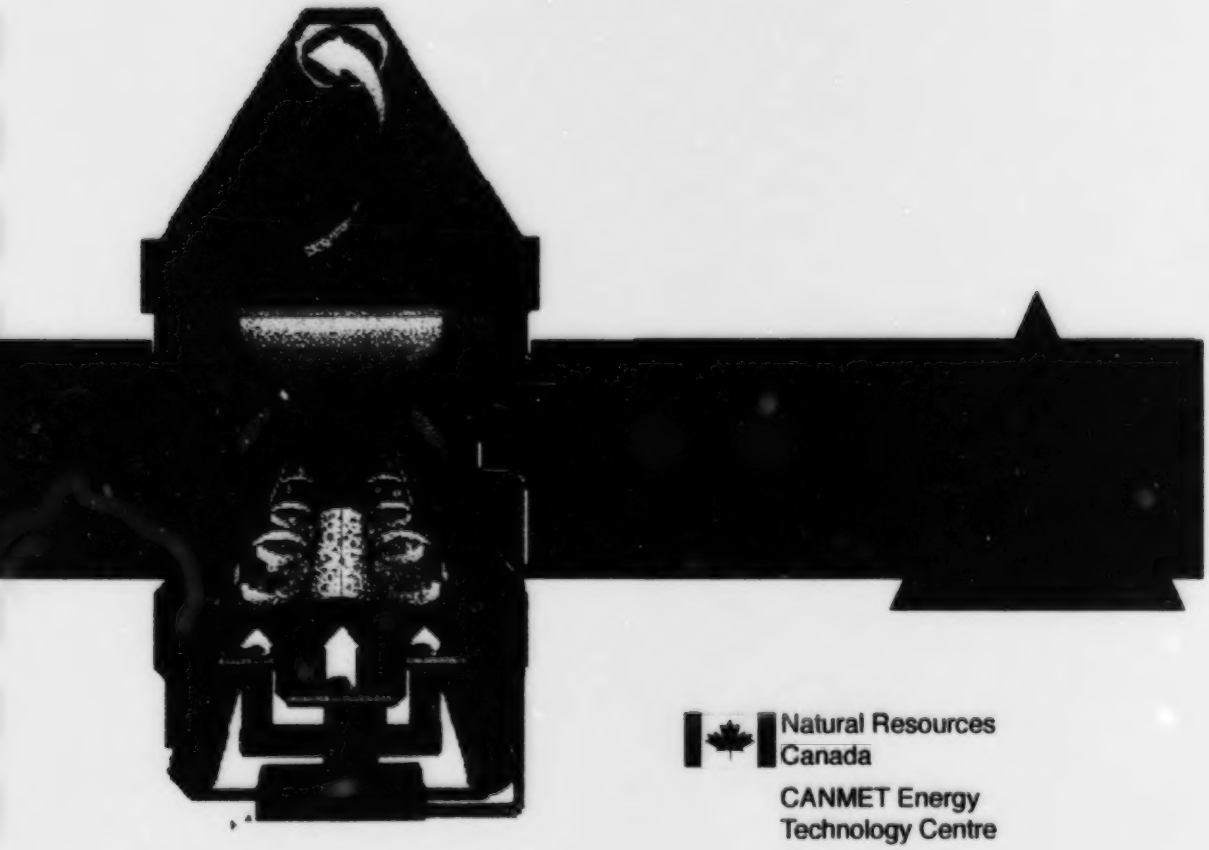
Alternative Use Assessment -

Fluidized Bed Incinerators
Sydney, Nova Scotia



Natural Resources Canada

CANMET Energy Technology Centre

in association with

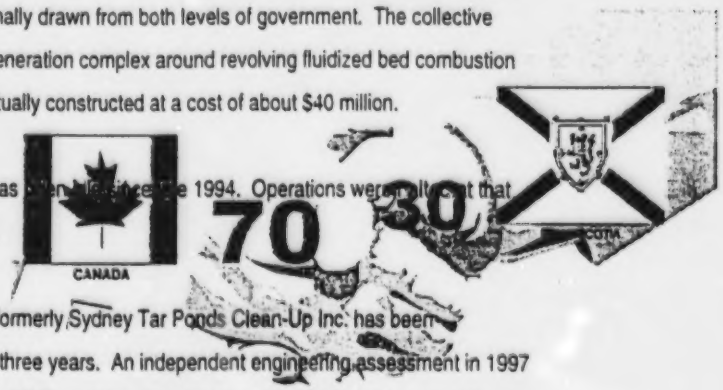
Jacques Whitford Environment Limited

Submitted to:

Sydney Environmental Resources Limited

PREAMBLE

Late in the 1980s, a federal-provincial partnership approved construction of a co-generation facility at the north end of the steel plant, in Sydney, as part of Phase I of a plan to clean-up the tar ponds. Led by Environment Canada and the Nova Scotia Department of Environment, the alliance operated on a 70/30 basis. It involved upwards of fifty officials proportionally drawn from both levels of government. The collective decision of the partnership was to develop the co-generation complex around revolving fluidized bed combustion technology. Twin fluidized bed furnaces were eventually constructed at a cost of about $40 million.



The specialized co-generation complex in Sydney has been idle since late 1994. Operations were halted at that time because of a lack of fuel – tar ponds sediment.

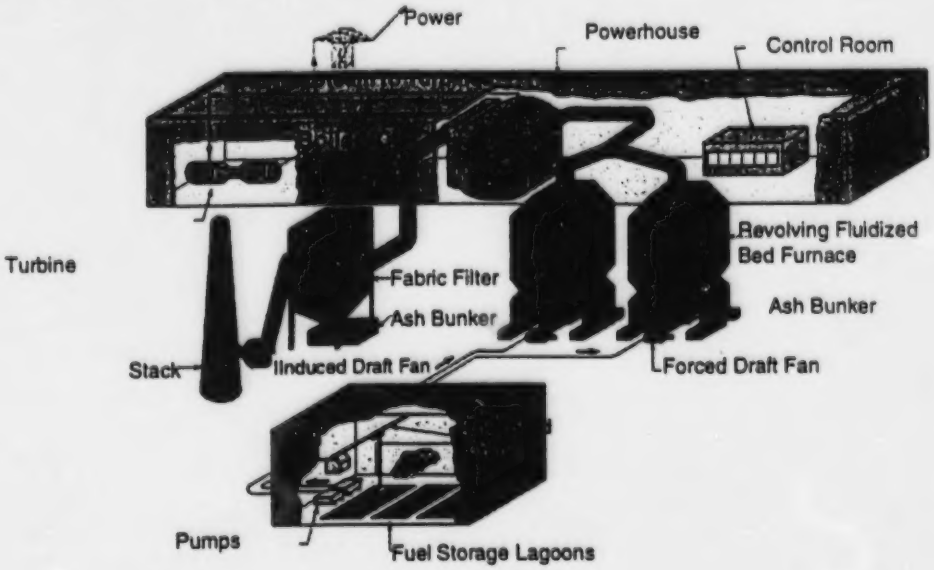
Sydney Environmental Resources Limited (SERL), formerly Sydney Tar Ponds Clean-Up Inc. has been maintaining the co-generation complex for just over three years. An independent engineering assessment in 1997 established that the fluidized bed combustion facility (FBC) would rapidly deteriorate if left idle. Consequently, SERL opened discussions on alternate use of the FBC complex. Toward the end of 1997, CANMET Energy Technology Centre (CETC), a division of Natural Resources Canada, was engaged to assess alternative use opportunities on a business case basis. Preliminary research established the need to broaden the original assignment. Subsequently, Jacques Whitford Environment Limited (JWEL) was added to the study team by CETC.

FBC units, like those in Sydney, are a significant chemical engineering technology. The technology has a variety of potential applications from oil refining to drying processes, solids handling systems, boilers, heat treatment furnaces and environmental protection measures. FBC units operate on feed stocks (fuels) as diverse as agriculture waste, municipal solid waste, wood wastes, industrial and municipal sludges, plastic, tires and coal. They are capable of efficiently combusting fuels of varying consistency.

Emissions from FBC units are inherently lower than conventional technologies because of low combustion temperatures and isothermal conditions within the boiler. These features, in combination with others, have allowed fluidized bed units to comply with some of the most stringent air quality regulations in the world. High combustion efficiency results in flue gases that contain low amounts of carbon monoxide. Together with others

these features have allowed fluidized bed units to comply with some of the most stringent air quality regulations in the world. The low combustion temperatures in the fluidized bed also minimize the formation of toxic materials such as heavy metals that might be released from the fuel.

Co-generation Complex, Sydney, NS



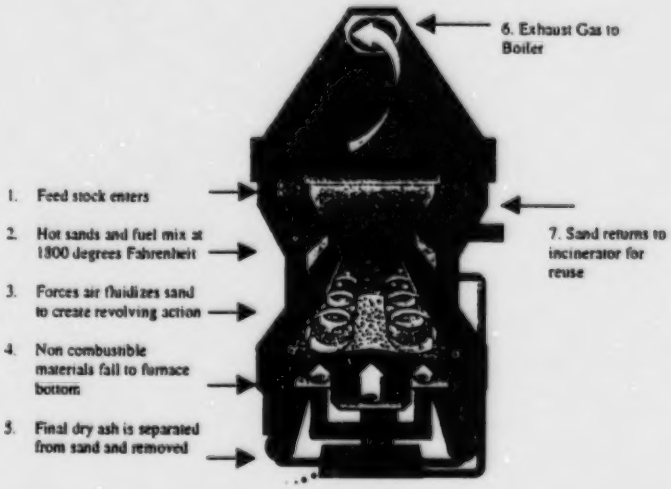
Fluidized bed installations are found in North America, Europe, Asia and Africa. World-wide there are several hundred operating fluidized bed units many of which are located in urban settings.

The revolving fluidized incinerators at the north end of the steel plant site burn feed stocks (fuels) by mixing the right combination of air, heat and sediments to ensure the material is completely destroyed. The incinerators contain a moving or fluidized bed of very hot sand that burns as air is blown up from the bottom of the bed.

Gaseous emissions from the bottom of the bed are fully burned in the incinerator's top section before the gas leaves the incinerator en route to the boiler. The hot gas is then cooled in the boiler. The heat extracted in this process creates steam, which turns a turbine to generate electricity. At the next stage, the cooled incinerator gas

is filtered through fabric bags in the bag house, prior to passing up a stack. Ash is collected from the incinerator bed, the boiler and the fabric gas-cleaning bags.

Expert testing in 1993 determined that the FBC units in Sydney passed the test stipulations of the Nova Scotia Department of Environment for emissions of pollutants to the atmosphere. Moreover, they meet the National Guidelines for Hazardous Waste Incineration Facilities by a factor of about 47 times lower than the minimum requirement. The overall destruction removal efficiency of the incinerators, in the case of PAHs, is 99.9953% and emissions were just less than half the limiting amount. Testing also established that with respect to dioxin and furan emissions, the values for the incinerator were over 20,000 times lower than the limit. Stack emissions of PCBs were measured during the original stack tests. No PCBs were detected. The average SO_2 removal efficiency was 89% as compared with the permit stipulations, which require a sulphur removal or capture efficiency of 80%.


6. Exhaust Gas to Boiler
1. Feed stock enters
2. Hot sands and fuel mix at 1800 degrees Fahrenheit
3. Forces air fluidizes sand to create revolving action
4. Non combustible materials fall to furnace bottom
5. Final dry ash is separated from sand and removed
7. Sand returns to incinerator for reuse

The CETC-JWEL study team determined that the FBC facility in Sydney requires modifications and upgrading. While significant, the cost of this work is thought to be substantially lower than the expense of replacing the system. In this context alternative use of the FBC facility, on a trial basis, burning non-offensive feed stocks as part of an expanded maintenance effort is possible but questionable. It would require access to appropriate fuels and ensured energy sales.

The FBC facility was originally intended as a hazardous waste destruction plant for contaminated materials from sites within Cape Breton County. It is concluded that the case for recommissioning must be on this basis. Employing the FBC units to destroy local hazardous feed stocks such as materials in the Domtar and Sysco tanks, Coke Ovens soil and tar ponds sediment would maximize long-term operating efficiencies and reduce operating costs.

Recommissioning the FBC facility to dispose of local hazardous waste would engender significant local economic benefits. Just under 85 person years of employment would result from modifications and improvements and more than 60 would be employed in FBC unit operations in the longer term.

As earlier noted, the FBC units met the '4-nines' (99.99% removal) for PAH sediments. The performance testing indicates that the removal efficiency of the units could be elevated to '6-nines', the standard for other contaminants some of which are known to be within a section of Cape Breton County known as the Muggah Creek Basin.

The Joint Action Group on Environmental Clean-Up (JAG) is presently considering safe, effective and environmentally acceptable remediation methods to clean up the Muggah Creek Basin. Incineration is understood to be one option currently under review. However, it would appear that JAG is at least several months removed from selecting a remediation technology. Further, it is understood that an environmental assessment is contemplated following adoption of a clean-up technique. This would suggest that actual on-site remediation activities might not begin for two to three years.

Recommissioning the FBC units on a trial basis burning non-offensive feed stocks is problematic and the current maintenance effort is insufficient to prevent irreversible deterioration. Consequently, there is risk that the technology will not be viable in the event JAG chooses the incineration option.

Assuming that the community can agree on the inherent value of the FBC units to the planned remediation of the Muggah Creek Basin, consideration must be given an enhanced maintenance program which would allow the technology to be suitably engaged within the next two to three years coincidental with JAG's current time lines.

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CANMET ENERGY TECHNOLOGY CENTRE

SERL FBCs - RECOMMISSIONING ANALYSIS

SYDNEY, NOVA SCOTIA

PROJECT NO. 12779

REPORT TO

CANMET ENERGY TECHNOLOGY CENTRE

ON

SERL FBCs - RECOMMISSIONING ANALYSIS
SYDNEY, NOVA SCOTIA

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April 24, 1998

EXECUTIVE SUMMARY

SYDNEY FLUIDIZED BED COMBUSTION FACILITY

ANALYSIS OF THE BUSINESS CASE FOR FACILITY RECOMMISSIONING

APRIL, 1998

EXECUTIVE SUMMARY

The Sydney fluidized bed combustion (FBC) units last operated in late 1994 and have been maintained since by Sydney Environmental Resources Limited (SERL), formerly Sydney Tar Ponds Clean Up Inc. The facility is now deteriorating rapidly. SERL has 3 options:

- decommission the facility and dispose of the units and materials, at near "scrap" value
- mothball the facility with complete long-term protection of all components
- recommission and operate the facility for waste types to be identified

In late 1997 SERL requested CANMET's Energy Technology Centre (CETC) to consider all aspects associated with Option 3. Jacques Whitford Environment Limited (JWEL), part of the CETC study team, was assigned the preliminary business case analysis and carried this out with the assistance of International Technology (IT) Corporation, the leading US remedial design contractor and the world's most experienced thermal remediation contractor.

SERL must urgently choose one of 3 options for the FBC facility:

- *decommission and scrap it*
- *mothball it properly*
- *recommission and operate it*

How did the Present Situation Arise?

The Sydney Tar Ponds clean-up history stretches back to 1984, when the Tar Ponds were confirmed as the source of contaminants throughout Sydney Harbour. In 1986, Canada and Nova Scotia signed a $34M agreement to proceed with clean up of the Tar Ponds by incineration. The project was to be executed in two phases. Phase I included design, construction and commissioning of the FBC facility, and was directed by a joint committee. Project participants included the Nova Scotia Government, Environment Canada (primarily responsible for decisions on process and technology) and Acres International Ltd (retained to manage on-site engineering, construction and commissioning).

STPCUI, a provincial Crown corporation established in 1991, was to take over the facility following its successful commissioning at the end of Phase I. However continuous operation had not been achieved by the time STPCUI received the facility in 1994. In 1995 STPCUI issued a world-wide proposal call for a contractor experienced in thermal remediation to manage the operations and complete the project. Competitive prices received from the tenderers were up to $185M - 3 to 4 times the original project budget. Alternative technical approaches did not receive public support.

In 1996 further delineation requested by STPCUI showed that PCB-contaminated sediment extended far further than estimated prior to 1994, resulting in a major escalation in project cost. This, coincident with renewed Federal Government interest, and the emergence of a community stakeholder Joint Action Group (JAG) encouraged by all three levels of government, resulted in the project being placed on hold in August 1996. SERL now has a mandate to maintain the FBC facility until the JAG determines its preferred approach to remediation of contaminated sites in the area.

What Uncertainties Remain in a Business Analysis at this Time?

The decision among SERL's three options for the FBC facility will have to balance many factors. While the business case analysis considers many of these, others can not be determined fully at present. Most important is that public acceptability of incineration remains uncertain. JAG anticipates full involvement in future decisions regarding use of the FBC units for any purpose. The FBC units were designed to meet 1980's "4-nines" destruction criteria, however "6-nines" is now common for many contaminants, including PCBs. With modifications, the FBC units could probably achieve such standards however this has not been verified. The current Industrial Waste Permit does not allow treatment of the significant volume of PCB sediment now identified in the Tar Ponds. Public acceptance of PCB incineration is uncertain.

Uncertainties affecting SERL's decision include:

- ? *public acceptability*
- ? *JAG role*
- ? *4-9s or 6-9s criteria*
- ? *PCBs in Tar Ponds*
- ? *contingency estimation*
- ? *lack of redundancy*
- ? *CBRM incinerators*
- ? *recycling requirements*
- ? *permit compliance*
- ? *changing regulations*
- ? *competitors*
- ? *union agreement*
- ? *SYSCO cooperation*

Continuous operation to verify design parameters (e.g. throughput rates, operating costs) has never been achieved and the system has little redundancy. Some operational compliance procedures are yet to be agreed. The labour agreement is under negotiation and the provision of services by SYSCO may be affected by future ownership changes. Contingency allowances are therefore difficult to estimate.

Regulatory expectations (e.g. environmental and labour) are continuously changing and would need to be confirmed at the time final recommissioning decisions are made. Viable and economic competing disposal options also exist for most waste types that could be taken by the FBC facility.

Consider Two Possible Approaches to Recommissioning

The FBC facility requires significant modifications and upgrading to address past problems and recent deterioration. Two approaches have been considered. ***Trial recommissioning*** would minimize initial costs and allow earlier start-up, but result in lower operating efficiencies and a temporary period of operations only. ***Aggressive recommissioning*** would cost more, but would maximize long-term operating efficiencies and reduce operating costs. For each approach, the facility could be recommissioned to handle various types of ***non-hazardous*** and/or ***hazardous*** waste feed materials. This creates four potential recommissioning scenarios.

Recommissioning options:

- *trial (temporary)*
- *aggressive (long-term)*

Feed materials considered:

- *non-hazardous*
- *hazardous*

Result: 4 scenarios

Factors considered in analyzing these scenarios include "disposal fee" revenues available from the producer of each waste type, costs to transport waste to Sydney, costs to upgrade the FBC facility, throughput rates and operating costs, and potential for cogeneration revenue to offset net operating costs. Other benefits accruing to the Sydney area following recommissioning are also considered.

What Revenue is Available from Alternative Feed Materials?

JWEL compiled information on feed materials, their sources, and present or future available volumes through review of existing information and detailed discussions with waste producers in the region. The potential was identified for SERL to receive payment for each material (e.g. in lieu of a "tipping fee" for the producer). The lowest road or rail transport cost from the producer's location to Sydney was determined for each material. Other major factors considered in evaluating the suitability of each feed material were public acceptability, competition with other public and private disposal options, and the viability of recycling - currently "preferred" for most materials.

Factors affecting potential to obtain revenue include:

- *volume*
- *"tipping fees"*
- *handling costs*
- *transport costs*
- *public acceptability*
- *competition*
- *recycling alternatives*

The community focus in Sydney is on the contaminated sites and other pollution problems in the Muggah Creek watershed area. The elimination of these concerns is JAG's priority. Although over $10M of revenue could be available from regional hazardous wastes that currently require disposal, and an additional $2-4M/year from continuing hazardous waste streams, support for the importation of hazardous wastes to Sydney for destruction at the FBC facility is currently unlikely. In addition, a number of private sector alternatives exist in Nova Scotia for disposal of most types of hazardous waste. Recommissioning the FBC facility to receive these may be viewed as government-supported competition. As a result, while hazardous waste types and sources outside Cape Breton were identified by JWEL for the purposes of completeness and comparison, these were not included in this business case evaluation as viable alternatives for the FBC units. ***Consideration of off-island wastes was therefore restricted to non-hazardous materials.***

Non-hazardous wastes

Non-hazardous wastes in Cape Breton include coal rejects and municipal solid waste (MSW). Since the CBRM incinerator currently takes 100% of the MSW generated in the region, this can be rejected as a viable separate feed source, although both this source and mining of the existing landfill may have future potential depending on the long-term waste management plans of CBRM. Most non-hazardous material sources with significant revenue potential for the FBC facility are in mainland Nova Scotia. Many of these (e.g. tires, wood waste) have viable commercial recycling options already in place and sustained public or regulatory support for diverting materials from recycling to incineration, even if cogeneration were included, is doubtful.

Costs to transport feed materials to Sydney are high since most non-hazardous waste materials (e.g. rubber, wood waste) are low density. Rail is the lowest cost for industrial sources in central or northern Nova Scotia with direct rail connections. However rates would be far higher unless substantial volumes were committed under a long-term contract. For waste sources south of Halifax, combined road/rail handling required would be prohibitive and road transport is preferred.

Typical transport costs to Sydney are high:

Rubber	*Granton*	*Rail*	*$21/tonne*
Rubber	*Waterville*	*Road*	*$66-71/tonne*
Rubber	*Bridgewater*	*Road*	*$66-84/tonne*
Wood	*Colchester*	*Rail*	*$37/tonne*

After the costs for handling and transportation are deducted from any "disposal fee" revenue, there is no non-hazardous material that could provide a significant positive net revenue for the FBC facility. However it is possible that the energy generated by the FBC units could be used for "cogeneration". Some waste types, such as rubber and coal, have the high calorific value necessary to be considered for this purpose. The total net revenues (or costs) to provide each non-hazardous material to the FBC facility were therefore determined.

Uncured waste rubber produced in the past by Michelin at its three Nova Scotia plants has been landfilled and there is no incentive to remove these wastes. Disposal fees would be negotiable for Michelin's ongoing uncured waste rubber and defective tires, but the annual volume is very small. Wood waste presently has a market value of up to $6/tonne in Nova Scotia and would have to paid for by SERL. Diversion of this waste from existing recycling options would be unlikely to receive support. The cost to "mine" MSW from the CBRM landfill would be significant. Other than the unlikely scenario of CBRM closing its incinerator and paying SERL a disposal fee there would be little benefit in taking ongoing MSW. No revenue is available for coal rejects.

Net revenues for SERL from non-hazardous waste materials are insignificant (or negative - i.e. costs):

Material	*Volume*	*Net revenue (cost)*
Ongoing waste rubber	*<2,000 T/yr*	*~$20,000 /yr*
Existing waste rubber	*<20,000 T*	*($1,000,000 total)*
Wood waste	*<15,000 T*	*($600,000 /yr)*
MSW - CBRM landfill	*80,000 T*	*($1,000,000 total)*
Ongoing MSW - CBRM	*50,000 T/yr*	*($400,000 /yr)*

Hazardous wastes

Potential sources of hazardous waste in Sydney are primarily associated with the Muggah Creek clean up activities and include the Benzol tank, Domtar tar cells, Domtar tanks, Sysco Tank Farm #2 tanks and contaminated soil throughout the Coke Ovens site and surrounding area. The Sydney Tar Ponds contain the largest confirmed volume of material - about 655,000 tonnes of PAH-contaminated sediment. (An additional 45,000 tonnes of Tar Ponds sediment is contaminated with PCBs). The Nova Scotia Government is the owner of the FBC facility maintained by SERL. Even if provincially budgeted funds were allocated to these clean-ups, they would not represent an "external revenue" source for SERL unless other levels of government assisted with project funding.

Costs to remove these wastes to the FBC facility would be low in most cases. However excavation of the Tar Ponds sediment is a major undertaking that in the past was largely responsible for project failure. The cost to dredge, prepare, handle and transport this material to the FBC units is a large part of the total costs for a successful Tar Ponds clean-up project. Some small additional amounts of contaminated soil will likely result from ongoing clean-up activities at other small sites in the Sydney area.

Estimated costs to take local hazardous waste materials to the FBC facility are:

Material	***Volume***	***Cost***
Benzol, Domtar, Sysco tanks	*12,600 T*	*$120,000*
Coke Ovens soil	*200,000 T?*	*$1,000,000*
Sydney Tar Ponds	*655,000 T*	*$36,000,000*
Other contaminated soil in CB	*10,000 T*	*$450,000*

Are Cogeneration Revenues Significant?

Efficient operation of the FBC units could produce useable electricity and heat, allowing the net operating costs for the FBC facility potentially to be offset by revenue (or savings) from cogeneration. Both electricity and heat production rates would be relatively independent of the type of material burned in the FBC units. Maximum potential generation rates are estimated to be about 6 MWe (electricity) and 16 MWt (thermal).

Efficient electricity generation would require upgrading of the turbine generator system. Use of thermal energy would require substantial equipment upgrading; replacement of the boiler system for steam generation, or addition of an air-based regenerative heat exchange system, as well as infrastructure to transmit and utilize the warm air produced. A maximum useable rate of 8 MWt should be used until options for thermal energy use are determined with more certainty. Electricity revenue of 2.9c/kWh and thermal revenue equivalent to 0.9c/kWh were assumed.

Trial recommissioning would result in inefficient FBC operation with intermittent stoppages, and would not justify the significant capital costs required to support reliable cogeneration. Aggressive recommissioning to achieve an 80% facility capacity factor could realize monthly electricity revenues of $102,000 and thermal revenues of $42,000. The total monthly cogeneration revenue of about $144,000 would offset the monthly operating costs for the facility.

Potential cogeneration revenues for the two recommissioning approaches:

Trial:	*Cogeneration excluded*
Aggressive:	*$144,000/month* *$1.7M/year*

Do Cogeneration Revenues Justify Recommissioning?

The evaluation of waste types and potential revenues showed that no feed materials provide a worthwhile positive revenue for the FBC facility. While the potential cogeneration revenues available following aggressive recommissioning are significant, they are far lower than the expected monthly operating costs for the facility. Operation of the facility in any mode would incur significant net costs for SERL. Cogeneration therefore can not support a stand-alone business case for FBC facility recommissioning, irrespective of the feed material used.

The case for recommissioning the FBC facility must be based on its original intended purpose - a hazardous waste destruction facility for contaminated materials from local sites.

This conclusion resulted in non-hazardous wastes not being considered further in the business case analysis, which was limited as a result to two scenarios: trial or aggressive recommissioning for hazardous waste materials.

Cogeneration does not support facility recommissioning on a stand-alone basis but can offset the operating costs as a hazardous waste treatment facility.

The minimal revenues from non-hazardous wastes do not further offset these costs.

What are the Costs for Recommissioning and Operation?

In 1985 the net cost of the Tar Ponds clean-up project was estimated to be only $7 million, with po cogeneration revenue offsetting most capital and operating costs. By 1993 significant cogeneration revenue was recognized to be unrealistic. The estimate was revised to $87 million, then again to $104 million in an independent 1994 report commissioned by STPCUI shortly after it assumed responsibility for the inoperational facility. However this report also noted that projected unit costs (per tonne of waste treated) were far below typical costs for other hazardous waste treatment facilities. It could be inferred that the real costs might be substantially higher, but that they could not be predicted reliably since successful sustained operations were never achieved to verify the design operating assumptions.

Tar Ponds clean-up project cost estimates rose rapidly from 1985 to 1995:

1985:	*$7 million*
1993:	*$87 million*
1994:	*$104 million*
1998:	*?*

JWEL had previously carried out detailed inspection of the FBC facility to identify upgrading requirements. This work was updated using a range of information sources including recent independent studies and discussions with present and former STPCUI/SERL personnel. Cost estimates were prepared and reviewed with SERL staff for both trial and aggressive recommissioni scenarios for hazardous waste treatment. Recommissioning requirements include regulatory activities, modifications to the FBC facility, addition of material feed handling systems, and addition of ash handling and disposal facilities.

Activities to address regulatory requirements and public concerns are similar for the trial or aggressive approaches, and include requirements under the environmental approvals and assessment processes, compliance testing, preparation of operation plans, training, and general site works.

Equipment modifications are limited to basic maintenance items for trial recommissioning, but more substantial modifications and upgrading are required to many components to achieve sustained maximum operating efficiencies under the aggressive scenario.

Recommissioning costs address:
- *regulatory activities*
- *equipment modifications*
- *materials handling system*
- *ash disposal*

Operating costs address:
- *treatment*
- *ash disposal*
- *maintenance*
- *staffing*

Failure of the excavating and transfer system to perform reliably was a prime factor in the previous project failure. Major modifications and addition of more versatile equipment are required to support continuous, efficient operations. Costs of excavation and transport handling for specific wastes (su as the Tar Ponds sediment) were considered previously as part of the "net revenue" analysis.

For short-term trial operations ash is assumed to be disposed of at the Sydney landfill. A tipping fe has not previously been negotiated. A cost of $30/tonne was assumed to cover transportation and tipping fees. Limited space at the Sydney landfill requires a new, dedicated ash landfill for long-term operations following aggressive recommissioning. Start-up costs assume a landfill is constructed w limited initial capacity. Operating costs include both ash handling and landfill extension with time.

Costs to operate the FBC facility following the two different recommissioning approaches are similar for most items, although aggressive recommissioning would improve the overall reliability of all the systems and reduce major maintenance costs. The most significant cost saving was assumed to result from the use of a conveniently located, SERL-operated ash landfill. Discussions with the CBRM might identify options for joint approaches to ash landfilling.

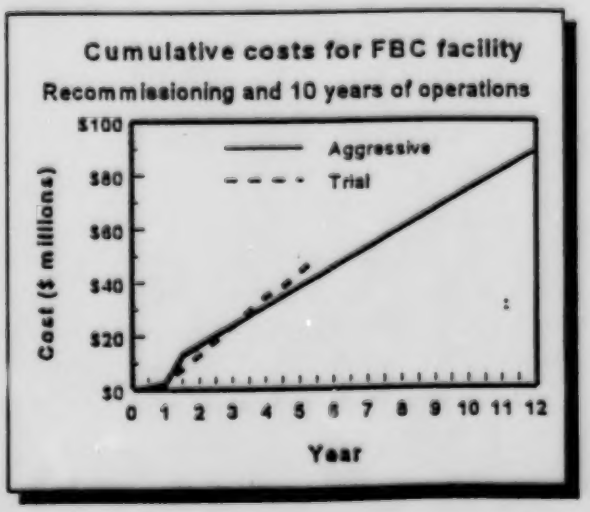
Total costs for recommissioning and operations are summarized in Table ES1. An aggressive recommissioning would cost about $13 million, significantly higher than a trial approach at $7 million. However the resulting benefits of the longer-term approach would be very substantial. The operating efficiencies and waste treatment rates would likely almost double, the operating costs would be lower, and significant cogeneration revenues could be realized.

The net operating cost following aggressive recommissioning would be only 2/3 of the operating costs following a trial recommissioning.

Table ES1 Costs for facility recommissioning and operation

Item	Trial	Aggressive
Recommissioning activities		
Regulatory requirements	$2,345,000	$2,395,000
Equipment modifications	$4,082,000	$8,758,000
Materials handling	$ 980,000	$1,660,000
Residuals disposal	-	$ 500,000
Total recommissioning cost	**$7,407,000**	**$13,313,000**
Operations		
Operating costs (monthly)	$891,000	$738,000
Cogeneration revenue	-	($144,000)
Net monthly operating cost	**$891,000**	**$594,000**
Net annual operating cost	**$10,700,000**	**$7,100,000**
Total costs for recommissioning and 2 years of operations	**$28,800,000**	**$27,600,000**

After only two years of operations, all the apparent cost savings achieved up front by the trial recommissioning would be lost, the waste volume treated would be substantially less, and major facility upgrading would still be required to sustain continued operations.



Comparison of the cumulative costs through recommissioning and continued operations for the trial and aggressive approaches confirms the lower costs for aggressive recommissioning.

Trial recommissioning is not justified for any operational scenario.

If the FBC facility is to be restarted to treat hazardous waste from the Sydney area, aggressive recommissioning activities should be carried out to achieve the maximum sustained efficiencies with minimum operating costs.

What Local Benefits would Result from FBC Recommissioning?

Recommissioning and operating the FBC facility to dispose of hazardous waste in the Sydney area would bring many benefits in addition to the safe, competent and most rapid clean-up of sites that have been a vexing community issue for many years.

Each year large amounts of contaminated sediment discharge from the Tar Ponds into Sydney Harbour. Although past studies suggested this release is less than 100 tonnes/year, analysis by JWEL suggests the actual discharge is more likely up to 100 times higher. Continued project delay, or a gradual long-term cleanup, is perpetuating the conditions that closed the fishery in 1982. Damming Muggah Creek at the mouth would create many other problems. Tar Ponds clean-up using the FBC facility, the fastest permanent approach, would lead to the earliest restoration of Sydney Harbour.

Any clean-up that included the Tar Ponds would rank among the largest, most complex and difficult, and most expensive ever carried out. As demonstrated by past experience, it would be critical to attain maximum operational efficiencies from the beginning of the project. Failure to achieve this would cause - at best - cost escalation by many tens of millions of dollars - and at worst another project failure with the Tar Ponds and other sites still not cleaned-up.

An experienced thermal remediation contractor with experience at comparable major sites would almost certainly be required to assist or manage recommissioning and initial operations. Most jobs and expenditures, however, would flow directly to the local labour force and to local suppliers.

Direct local benefits include:
- *rapid clean-up of Sydney sites*
- *earliest harbour restoration*
- *up to 84 initial local jobs*
- *over 60 long-term local jobs*
- *major local expenditures*

Technology transfer would include:
- *FBC operation*
- *advanced materials handling*
- *environmental monitoring*
- *advanced health & safety processes*
- *QA/QC methods*
- *advanced data management systems*
- *advanced project management*

Community programs could include:
- *community liaison/advisory groups*
- *school programs*
- *site educational tours*
- *UCCB educational programs*
- *Co-op student training*
- *Haz-waste remediation conferences*

Long-term assets would remain:
- *clean, valuable sites*
- *buildings and other facilities*

Substantial and immediate transfer of state-of-the-art technology, knowledge and operational expertise would accrue in Sydney. This would occur far faster than if "emerging" technologies were explored over a longer time frame. The risk of project delay or failure would be minimal. The community would maximize leverage of its existing asset and receive real and immediate economic benefits. Considering that the remediation industry in North America is mature and declining, this also represents the best - and perhaps the only - real opportunity for the Sydney community to acquire expertise that could later be exported.

Summary and Conclusions

JWEL has evaluated the commercial case for recommissioning the Sydney FBC facility, as an alternative to the decommissioning or major mothballing otherwise required due to rapid deterioration of the units. The analysis identified feed materials that might offer revenue to support a stand-alone commercial operation. Other factors were identified that affect the regulatory or public acceptability of bringing these materials to the facility. Two options: trial recommissioning for short-term operations, and aggressive recommissioning for long-term use of the facility, were considered. The start-up and operating requirements for each approach were costed. Use of cogeneration revenues to offset operating costs was included. Based on this analysis, the following conclusions are evident:

1. Public support for importation of off-island hazardous wastes to Sydney for destruction at the FBC unit, even if these were revenue-generating, would be low.

2. After deducting transportation costs from "disposal fee" revenue, no non-hazardous waste source could provide a significant positive revenue for the facility.

3. Cogeneration revenues would not support a stand-alone commercial case for recommissioning.

4. ***Recommissioning is therefore only justified if it is for the original intended purpose of the facility - to treat hazardous waste from local contaminated sites.***

5. "Special" wastes in the Sydney area, such as PCBs, could probably be destroyed successfully and safely by the modified FBC units, but public support for PCB incineration is currently weak.

6. Successful long-term operation to verify operating assumptions had not been achieved when STPCUI took over the facility in 1994. Previous cost estimates for the Tar Ponds project were too low.

7. Significant work is required to recommission the FBC facility for sustained, efficient operations without risk of further project failure. Regulatory activities and facility modifications would take up to a year. This could be substantially longer if environmental assessment activities were required

8. Trial recommissioning would cost about $7 million, with annual operating costs about $10 million but with low waste treatment rates and high risk of ongoing major shutdowns. Costs to excavate and transport waste to the facility are separate and may be significant, e.g. for the Tar Ponds.

9. Aggressive recommissioning would cost about $13 million, but would result in lower operating costs of $7 million per year, with high sustained treatment rates and minimal risk of project failure. After less than two years of operation the aggressive approach would have lower total costs.

10. ***Trial or temporary recommissioning is not justified under any scenario.***

11. ***Aggressive recommissioning would produce a viable treatment facility that would be ideally suited to destroy the large hazardous waste volumes present in the Sydney area.***

PROJECT NO. 12779

REPORT TO

CANMET ENERGY TECHNOLOGY CENTRE

ON

SERL FBCs - RECOMMISSIONING ANALYSIS
SYDNEY, NOVA SCOTIA

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TABLE OF CONTENTS

Page No.

1.0 INTRODUCTION 1
- 1.1 Purpose 1
- 1.2 Uncertainty Factors 2

2.0 POTENTIAL FEED MATERIALS AND REVENUES 4
- 2.1 Introduction and Approach 4
- 2.2 Transportation Methods and Costs 5
- 2.3 Non-Hazardous Feed Materials 7
- 2.4 Hazardous Waste Materials 13
- 2.5 Other Waste Streams 16

3.0 COGENERATION COSTS AND REVENUES 19

4.0 COSTS FOR RECOMMISSIONING AND OPERATION 20
- 4.1 Regulatory and Public Acceptability Requirements 22
- 4.2 Required Modifications to FBC Incinerators 24
- 4.3 Materials Handling 25
- 4.4 Residuals Disposal 26
- 4.5 Operating Costs 27
- 4.6 Summary of Costs for Recommissioning and Operations 28
- 4.7 Required Modifications to Support Thermal Destruction of PCBs 30

5.0 POTENTIAL LOCAL BENEFITS 31
- 5.1 Local Benefits 31
- 5.2 Technology Transfer 33

6.0 SUMMARY AND CONCLUSIONS 34

7.0 RECOMMENDATIONS 36

8.0 CLOSURE 37

9.0 REFERENCES 38

APPENDICES

A1 Background to the FBC incinerator project
A2 Summary of feed material characteristics
A3 Off-Island Waste Background Information
A4 Modifications to the FBC units

1.0 INTRODUCTION

1.1 Purpose

Successful continuous operation of the fluidized bed combustion (FBC) facility originally designed and constructed to treat contaminated sediments from the Sydney Tar Ponds had never been achieved when it was transferred from joint federal/provincial jurisdiction to Sydney Tar Ponds Clean Up Inc. (STPCUI) in 1994. It has been maintained since by STPCUI, now Sydney Environmental Resources Ltd (SERL), pending recommendations by the community Joint Action Group (JAG) on preferred remedial options for local contaminated sites. The history leading to the current status is described in Appendix 1. The facility is now deteriorating rapidly (Strum Engineering Associates, 1997) and will soon have no useful life unless actions are taken. SERL has only three options:

1. Decommission the facility and dispose of the units and materials, probably at near to "scrap" value.
2. Mothball the facility, with full long-term climatic and corrosion protections of all parts.
3. Operate the facility using available waste types, with recommissioning modifications as required.

In late 1997 SERL commissioned the CANMET Energy Technology Centre (CETC) to carry out a technical and preliminary financial evaluation for Option 3. In December 1997 CETC asked Jacques Whitford Environment Ltd (JWEL) , part of the study team, to prepare this business case analysis. JWEL carried this out with the assistance of International Technology (IT) Corporation, the leading US remedial design contractor and the world's most experienced thermal remediation contractor.

The report analyzes two scenarios for recommissioning and operations. "**Aggressive recommissioning**" would achieve maximum long-term operating efficiencies. "**Trial recommissioning**" would minimize initial costs, but would result in lower operating efficiencies for a temporary period of operations only. For each, recommissioning the units to burn "**non-hazardous**" and "**hazardous**" wastes has been considered separately to give four potential scenarios: two waste type categories for each of the two levels of recommissioning.

Section 2 identifies net operating revenues available from different waste types, considering "disposal fee" revenues at source and deducting costs to transport waste to the FBC facility in Sydney. Potential cogeneration revenue is estimated in Section 3. Section 4 evaluates start-up and operating costs for each recommissioning scenario. Start-up costs consider activities to obtain regulatory approvals and public acceptance and modifications to the FBC facility and materials handling system. Aggressive recommissioning would construct a dedicated long-term residuals disposal facility to minimize disposal costs, but trial recommissioning would negotiate temporary commercial disposal at the existing Sydney landfill.

Section 5 identifies other direct benefits and opportunities for the local community if the FBC facility were recommissioned. Section 6 summarizes conclusions from the analysis and presents recommendations.

1.2 Uncertainty Factors

Many factors introduce significant uncertainty into the business case analysis of future recommissioning and operations for the FBC facility. While some of these factors are taken into account in the analyses presented in this report, the effects of others can not be determined at this time. Some examples include:

- Public acceptability of waste incineration is uncertain. The burning of biomedical waste in the existing CBRM solid waste incinerators has recently attracted adverse attention. The JAG has not yet formally considered or established a position on either incineration as a remediation option, or the SERL incinerators as an appropriate technology if incineration is supported. As the group recommending remedial approaches to Government, JAG would expect to be involved fully in discussions leading to a decision on the future of the FBC facility.

- The FBC incineration system was originally designed to meet the "4-nines" (99.99% removal) environmental criterion current in 1985-87. Although this remains the Canadian standard for PAH removal, the standard for many other contaminants both in Canada and elsewhere is now "6-nines" (99.9999% removal). The performance testing in 1993 indicated that "6-nines" requirements could probably be met, however sustained performance of the FBC facility to these higher standards, or for a range of contaminants, has not been verified by specific testing for this purpose. If such criteria were imposed as part of future regulatory approvals, some equipment modifications and enhancements could be required to meet these standards on a sustained basis.

- The current Industrial Waste Permit prohibits the incineration of sediment with PCB concentrations greater than 50 ppm. At the time of the original project design a range of alternative PCB treatment technologies were expected to become available. However incineration remains one of the only viable and widely accepted destruction techniques for PCBs. During the period of construction and commissioning of the incinerators it become increasingly apparent that they would be a more viable candidate technology for the PCB destruction than was originally anticipated. Although previous testing suggests the FBC incinerators could probably meet the 6-nines regulatory criteria for PCB removal, future public acceptance of using the FBC facility to destroy PCB material is uncertain.

- The FBC incinerators have never been operated on a continuous feed basis extending over a period of many months. Operating costs projected originally were based on design throughput rates being achieved. These design rates have not been verified by continuous operations and may not be attainable. Continuous operating experience may encounter other unidentified factors that would need to be addressed by changes to the operational process. Further equipment modifications or additions may also be required to optimize performance. Estimating reasonable contingency allowances for startup and operations is therefore difficult.

- There is relatively little redundancy in the FBC system. This may affect future operational performance or require future equipment additions or modifications.

- Some of the waste types considered for the FBC facility recommissioning are also feed materials for the CBRM incinerators, or could be used to supplement the current solid waste feed. CBRM should be consulted prior to any further consideration of diverting these wastes to the FBC facility.

- Provincial requirements and enforcement remain uncertain regarding some aspects of waste material recycling. Difficulties may arise in obtaining approvals for incineration of some of these wastes.

- Operational compliance with the present Industrial Waste Permit (and future environmental approvals) may be affected by interpretation of the requirements in several areas including: correcting CO stack concentrations for O_2, temperature and moisture; the method for determining time-averaged SO_2 removal; and standards stated in the existing permit compared to other regulatory standards.

- Changes in environmental, labour and other regulatory standards may result in changes to both the recommissioning and operating requirements during the course of a long-term project. This possibility increases with continued delays to the project.

- Commercial competitors to the SERL FBC facility exist for many of the alternative waste types considered. These competitors can offer pricing or disposal costs that will compete favourably with transport and disposal in the Sydney FBC facility. Private sector opposition to recommissioning of the FBC facility for alternative treatment uses other than Muggah Creek waste materials is likely.

- A collective agreement currently exists between SERL (as STPCUI) and the United Steelworkers of America Local 1064-02, (the "Cape Breton Industrial Projects Collective Agreement"). This labour agreement is currently under negotiation and implies uncertainty regarding future operating costs.

- SERL currently relies on some services from or cooperation with SYSCO, such as supply of water and site access. Negotiations are understood to be in progress for the sale of SYSCO to foreign buyers. It is not known what relationship will exist between SERL and SYSCO in the future.

SERL should review all these areas of uncertainty, and identify others, prior to proceeding with active consideration of the three options for the FBC facility.

2.0 POTENTIAL FEED MATERIALS AND REVENUES

2.1 Introduction and Approach

Two categories of potential feed materials have been developed for the purposes of this business analysis of the FBC facility: non-hazardous and hazardous wastes. The assignment of waste categories for different material types is in some cases based on experience rather than regulatory distinctions, and should be considered as being for the purposes of this preliminary analysis only.

Potential sources of feed materials were initially identified based on "A Study on Alternative Uses for the Twin Sydney Tar Ponds FBC Boilers", a draft Division Report by the CANMET Energy Technology Centre (CETC) of Natural Resources Canada. A number of additional sources were compiled based on JWEL's knowledge of local and provincial industries and the structure of waste disposal networks and regulations in the Atlantic provinces.

Waste producers were interviewed to determine the viability of considering their waste as potential feed material, with particular consideration placed on their current disposal methods and costs. Three additional factors were considered when assessing the potential viability of feed materials:

- public acceptability issues
- issues of competition with independent, private companies
- recycling vs incineration issues

Transportation costs from the source of each waste to Sydney are very significant. As an example, existing contaminated soil recycling facilities in Nova Scotia typically consider they can not be competitive with alternative disposal options for road transport distances much greater than about 200 km. Transportation costs are therefore considered separately in Section 2.2. Both road and rail transport are addressed.

Sections 2.3 and 2.4 summarize the potential sources of feed materials by waste category. Issues discussed include the available revenue at source, market factors, transportation costs and the three considerations identified above. The information for each waste category is summarized in tables at the end of each subsection. Section 2.5 summarizes, for information and comparative purposes only, other waste sources such as the Tar Ponds PCB-sediment and off-island waste which are not included in the revenue analysis.

Each section on potential waste material sources and revenue concludes with an analysis of potential revenues. Where appropriate, the costs to obtain the material (e.g. landfill mining) and the transport costs to Sydney are subtracted from the available revenue at source to determine the net revenue for each waste type upon delivery to the FBC facility.

2.2 Transportation Methods and Costs

2.2.1 Road Transport Costs

Transportation of non-hazardous materials is straightforward. Generally the materials can be transported by tractor trailers or flatbeds. NSDTPW "truck rates" (tonne-kilometre rates) were used as the basis of estimating road transportation costs for "denser" materials such as contaminated soil. Rates for light and bulky wastes, such as rubber and wood waste, were estimated to be 2 to 3 times the provincial tonne-kilometre rates. Transportation of hazardous goods is more costly. Rates for wastes with specific regulatory transportation requirements were estimated to be 2 to 3 times higher than conventional rates.

2.2.2 Rail Transport Costs

Rail transport appears to offer significant cost savings potential for transporting some types of waste from their current source to Sydney. Cape Breton and Central Nova Scotia Railway (CBNS Railway) operates the route from Truro to Sydney, with a number of sidings along the way. The Windsor & Hantsport Railway operates a connecting route to locations in the Annapolis Valley, and other main line routes from Halifax through Truro out of Nova Scotia are operated by CN Rail. CBNS Railway have provided JWEL cost estimates for waste transport by rail, combining operator routes where necessary, after considering the available information on relevant waste sources and volumes. These rates apply for rail to rail transport only and do not include loading, unloading, bracing or blocking of loads where required. It is the shipper's responsibility to ensure the loads are secure and that all regulatory requirements are met. The rates provided were based on a minimum annual guaranteed volume of traffic that is equivalent to about 80,000 tonnes of waste per year. While basic rail rates initially appear attractive, additional costs could exceed $5/tonne for handling, loading and unloading, and appropriate containment to comply with regulatory requirements.

A number of the waste sources are not at or near any rail routes, such as Michelin's Bridgewater plant. Waste from this, and from numerous smaller sources, contribute over two thirds of the total potential waste volume. These wastes would require separate trucking to the nearest rail point, adding significant double handling costs as well as the basic trucking costs.

Source-by-source analysis of rail transport costs suggests that rail transport could be up to 40% lower than road transport for large volumes of wastes at locations with direct rail connections between Truro and Sydney. As an example, this might represent $10-15/tonne for rubber wastes from Michelin's Granton plant. More distant locations would probably see savings less than 20% over road transport. However wastes from source locations without direct rail connections would likely see little overall savings from combined truck/rail transport. Based on these factors it is unlikely that anywhere close to 80,000 tonnes/year of rail traffic would be generated for rail traffic, and the pricing estimates provided by CBNS Railway would have to be increased accordingly, making rail transport less attractive in some cases.

Considering all potential waste types, source locations and relative total costs for road and rail transport, it is likely that less than 20% of the total potential waste volume in Nova Scotia outside Cape Breton would see significant cost savings if transported by rail rather than road. This preliminary analysis could change following selection of a specific recommissioning approach and preferred waste types, if transport options and costs were negotiated on a waste-specific and long-term basis.

Figure 2.1 demonstrates typical road and rail transport costs with increasing distance from Sydney for different waste types. Much of the potential waste is at sources from 300 to 500 km from Sydney. The furthest "cost" contour from Sydney in Figure 2.1(a) is typical for transport costs from these sources to Sydney. Road transport costs for this distance are about $60-$90/tonne for low density materials such as rubber and wood waste. This demonstrates that transport costs would represent a major consideration in the overall evaluation of the viability of treating waste from around the province at the Sydney FBC facility. As discussed above, rail transport offers savings only for some sources and waste types in central to northern Nova Scotia.

Figure 2.1a - Typical road transport costs: low density materials (rubber,wood)

Figure 2.1b - Typical rail transport costs: low density materials for guaranteed minimum, long-term supply

Figure 2.1 - Transport costs for various material types and transport modes

2.3 Non-Hazardous Feed Materials

Potential feed materials considered non-hazardous include rubber waste (cured and uncured), used tires, municipal solid waste (MSW), coal rejects and wood waste. A summary of waste material characteristics is presented in Appendix 2, Table A2.1.

2.3.1 Sources and Market Factors

Rubber Waste

Michelin Tires (Canada) Limited owns three tire manufacturing facilities in Nova Scotia. The plants in Granton and Bridgewater were opened in 1971, while the plant in Waterville opened in 1982. Michelin generates uncured (green) and cured rubber (as scrap rubber and defective tires from the final product line).

The cured scrap rubber, including the defective tires, presently goes to independent recycling companies (about 900 tonnes/yr total from all three plants). The uncured rubber is of no use to recycling companies and has no market value. This material, which Michelin estimates is about 770 tonnes per year (total from all three plants), is currently disposed in municipal landfills in proximity to each of the three plants.

The amount of uncured rubber available for the FBC facility could be increased by excavating material previously placed in landfills. This would require that the location of the rubber is known in each landfill and that material handling difficulties could be overcome. The uncured rubber is cohesive and tends to form one large mass after disposal. It could be cut into more manageable pieces by chain saw, but extreme care would be needed to avoid possible injury from cutting into steel belting. The significant heating value of the uncured rubber could offset the costs associated with mining the material. Assuming a total of 64 operating years (total for all three plants) and a suggested average yearly quantity of 250 tonnes of uncured rubber produced per plant, Michelin has possibly disposed of up to 16,000 tonnes of the material in local municipal landfills.

While Michelin agrees it would benefit from a viable incineration option for its uncured rubber waste, the price to incinerate defective tires would have to compete with the independent tire recycling companies for this source. Issues to be considered when assessing cured rubber as a potential feed material are competition with private companies (recyclers) and the acceptability of incineration versus recycling. These issues do not arise for uncured rubber since recycling is not viable and land disposal is currently required.

Used Tires

According to the Resources Recovery Fund Board Inc., more than 900,000 tires are disposed each year by Nova Scotians. Under Section 30 (1) of the Nova Scotia Solid Waste-Resource Management Regulations, used tires are banned from landfills and incineration. An agreement between the Resource Recovery Fund Board Inc. and TRACC Nova Scotia has resulted in a government supported recycling program. TRACC collects used tires from retailers for use in their recycling operation. TRACC officials have indicated that

there is no residual rubber from their process. It is therefore not advantageous to pursue used tires as a feasible source in Nova Scotia, as public acceptability of recycling is much greater than for incineration. For other areas of Atlantic Canada where tires have not been banned from landfills, transport costs to Sydney would be very high and there would be little incentive to divert tires from landfills. Used tires have therefore not been carried in the revenue analysis based on the regulatory constraints, the preference for recycling over incineration, and the existence of private recycling companies.

Municipal Solid Waste (MSW)

Under Section 34(e) of the Nova Scotia Solid Waste-Resource Management Regulations, an application for approval to operate an incinerator of municipal solid waste (MSW) must describe how the incinerator will generate energy. Therefore, only waste-to-energy incinerators are permitted to burn MSW in Nova Scotia.

The Cape Breton Regional Municipality (CBRM) currently operates a landfill and incinerators. The Municipality has expressed interest in incinerating material from sections of the Sydney dump. Due to leachate problems, it has been considering either mining and incinerating this material or relocating it to a more up-to-date landfill. The dump is reported to have received waste for the past 30 - 40 years. It is estimated that the volume of MSW is in the order of 365,000 m^3. Past experience in landfill mining suggests that only the top, or newest, third would contain viable feed material for energy production. Assuming a MSW density of 700 kg/m^3, approximately 85,000 tonnes of MSW could be available to be mined and incinerated for energy production. Current supply of MSW to the CBRM incinerator is about 50,000 tonnes/year. For the contributing population of approximately 80,000 people, this waste volume is consistent other regions of Nova Scotia.

Two opportunities are therefore available for the raw and mined MSW from CBRM. The Municipality currently incinerates approximately 1000 tonnes of MSW a week. If its incinerators were unable to meet demand, excess MSW could be diverted to the FBC. The second opportunity involves the mining of the existing landfill. This would allow the Municipality to expand the useful life of the landfill by increasing disposal volume but not the areal extent of the landfill. If it is assumed that the labour and equipment costs to mine the landfill are shared, the Municipality could realize a cost-effective approach to increase its solid waste disposal capabilities. While there would probably be fewer direct public acceptability issues associated with an MSW waste stream, there would be an issue of "competition" with the Municipality. Incineration of MSW would in addition be counter to the trend to encourage the recycling of waste-resource material.

The Pictou County Planning Commission is currently separating organics from its waste stream for composting. The Commission separates approximately 7,000 tonnes/year of organics (mainly food waste) and 3,000 - 4,500 tonnes/year of domestic sewage sludge. The Commission is currently seeking a full-service company or consortia to finance, design, build and/or operate a source-separating composting facility. The Commission has stated that if incineration proved more cost effective it would consider it an alternative to composting. However current provincial regulations may prevent incineration of compostable material.

Under Section 34(f) of the Nova Scotia Solid Waste-Resource Management Regulations, an application for approval to operate an MSW incinerator must provide an assessment of how the incinerator will not reduce or take away opportunities for recycling, composting or other reprocessing of waste-resource material. It is also likely that the public would be more supportive of composting than of incineration. Because of the regulatory issues and likely competition with private industry (to design/build/operate composting facility), this waste source is not carried in the revenue analysis.

Coal Rejects

The Cape Breton Development Corporation (Devco) generates two types of coal rejects, coarse and fine tailings. These waste materials, in the order of 33,000 tonnes/year, are currently disposed of in on-site lagoons and landfills, respectively. A second source of coal rejects is Donkin Resources Limited, operators of the Donkin Mine, slated to open in 1998. Donkin Resources anticipates 40,000 tonnes of coal rejects per year, with the amount potentially doubling by the year 2000.

As Devco currently disposes of its coal waste on site, this does is not a revenue opportunity. Acquiring the waste material from Donkin Resources would incur transportation and handling costs, and Donkin Resources expect a percentage of any net return from the use of this material for power or process steam generation. The production of coal in Cape Breton has been decreasing in recent years. There are production problems, the main buyer of the coal, Nova Scotia Power Incorporated (NSPI), has increasingly met its requirements for coal from elsewhere and Devco recently announced the closure of exports from the international pier in Sydney for at least two years. With the inevitability of natural gas as a new energy source in Nova Scotia, it is uncertain how consistent a supply of coal rejects would remain in the future.

Wood Waste

Conventional wood waste includes sawdust, bark and shavings from whole trees as well as used wood products such as building materials and construction debris. The latter often require reprocessing prior to incineration to ensure a suitable feed material.

Most mills use the majority of their wood waste for internal energy generation or sell it to a nearby mill with a shortage of wood waste. The Brooklyn Energy Centre, a 22.5 MWe wood waste-fired combustor in Brooklyn, NS, is a large sink for much of the waste generated in the western half of Nova Scotia. Several lumber companies in Pictou and Colchester counties would make their wood waste available for a price. Competition for this material includes local pulp mills, farmers and landscaping companies. Julimar Lumber, in Pleasant Valley, and Gammco Ltd. in Scotsburn produce 25 - 30 tonnes (mixture of bark and sawdust) per day. Julimar sells its wood waste to the Brooklyn Energy Centre while Gammco Ltd. sells its wood waste to Kimberly-Clark in Pictou, its sawdust to farmers and its bark to landscaping companies.

The largest construction and demolition debris recycling company in the Halifax region has insufficient wood waste to fill its markets for second-hand lumber, garden mulch and wood chips. This indicates that the supply of wood waste cannot fill the demands and that it may not be a stable, cost-effective feed material.

Michelin Canada does not have a market for approximately 700 tonnes of wooden pallets it receives per year. The pallets are stockpiled or used for fire-training. Michelin would provide them at no cost, excluding transportation. When assessing the viability of this material as a feed source, issues to consider include recycling vs incineration, since other markets for wood waste exist that involve re-use rather than disposal.

Table 2.1 summarizes the above information on quantities of non-hazardous feed materials.

2.3.2 Potential Revenue

Rubber Waste

Michelin currently pays a tipping fee of $35/tonne to dispose of its uncured rubber at local municipal landfills and pays $1 to $1.50 per tire to recycling companies for disposal of defective tires. SERL would have to charge less than these amounts, and collect the rubber and tires from the Michelin plants, to be competitive. Based on yearly estimated quantities of 770 tonnes and 900 tonnes for uncured rubber and scrap rubber, respectively, and the tipping fees Michelin currently pays, the potential exists for approximately $100,000 in annual revenues from tipping fees for this material. This excludes the cost of transportation.

There is no revenue associated with uncured rubber mined from municipal landfills. Labour and equipment costs would be incurred for the removal, and transportation costs to Sydney would have to be added.

Municipal Solid Waste

Potential revenues generated by the incineration of MSW from the Cape Breton Regional Municipality would have to be negotiated with the Municipality. Since the Municipality has its own incinerators, the arrangement would have to be very cost effective to interest the Municipality (potentially through sharing of power generation revenue). This is unlikely. There is no tipping fee revenue associated with the MSW mined from the local landfill. A cost-sharing approach with the Municipality could possibly be negotiated as it would benefit from the additional space created in the landfill after the mining operation. Costs for mining of landfills are highly variable but can typically be in the order of $7 to $8/tonne.

Coal Rejects

No tipping fee revenue can be expected from CBDC or Donkin Resources for their coal rejects. In addition to transportation costs, Donkin Resources states that it would expect a percentage of any net return associated with the use of this material for power or process steam generation.

Wood Waste

Julimar and Gammco sell their material for $6/tonne and $7/tonne, respectively, excluding transportation. Michelin would provide its stockpiled pallets for no charge, excluding transportation costs.

Table 2.1 Summary of Non-Hazardous Feed Materials

Waste material and source	Quantity (tonnes)	Market factors	Major public acceptability issues ?	Major competition issues ?	Major recycling issues ?	Suitable for FBC?
Rubber Waste Uncured (green) rubber Michelin	770/yr 16,000 landfilled	Material is landfilled, cannot be recycled.	No	No	No	Yes
Scrap rubber (inc. defective tires) Michelin	900/yr	Material recycled by independent recycling companies.	No	Yes	Yes	Yes
Used tires Post-consumer waste	900,000 tires/yr	Tires recycled through provincial government-supported program at a privately-operated tire recycling plant (TRACC). No remnant material. Used tires are banned from incineration.	No	Yes	Yes	No
Municipal Solid Waste ·· "Raw" MSW CBRM	50,000/yr	Incinerators must be equipped to generate energy under Section 34 (e) of Solid Waste -Resource Management Regulations.	No	Yes	Yes	Yes
Mined MSW CBRM	85,000 total	Effective approach if CBRM is interested in expanding life of landfill but not the size.	No	No	No	Yes
Compostable material Pictou Co. Planning Commission	10,000/y	Commission currently separates organics from waste stream for composting. Current provincial regulations do not allow incineration of compostable material.	No	Yes	Yes	No
Coal Rejects Coarse and fines Cape Breton Development Corp.	33,000/yr	No tipping fee; Devco disposes of waste on site. Declining demand for CB coal. Production problems.	No	No	No	Yes
Donkin Resources	40,000 - 80,000/yr	Mine not operational. Donkin Resources will charge for transport & expect % of return from cogeneration.	No	No	No	Yes
Wood Waste Julimar Lumber, Brookfield Gammco Limited, Pictou	13,000/yr	Costs to obtain and transport material. Competition for material from pulp mills, farmers and landscapers.	No	No	Yes	Yes
Pallets Michelin	700/yr	No demand for pallets, stockpiled/used for fire training.	No	No	Yes	Yes

Table 2.2 summarizes the potential net revenue generated by non-hazardous waste sources. "Revenue at source" was determined on a $/tonne basis, by deducting from the "disposal fee" (or "avoided cost" that a current owner would pay to have the waste removed) the cost to extract the material from its current location (e.g. mine solid waste from CBRM landfill). The "transport cost" to Sydney ($/tonne) includes costs to meet regulatory requirements and provide appropriate containment. Deducting the lower of road or rail cost gives the "net revenue" for delivery at the FBC facility ($/tonne). The yearly revenue ($/yr) is shown for wastes generated on an ongoing basis, and the total revenue ($) is shown for existing wastes with known volume.

Based on this analysis, it is evident that there is no stand-alone commercial case for treating non-hazardous wastes in the recommissioned FBC facility. Only three of eighteen wastes generate positive revenue; defective tires and uncured rubber from Michelin's Granton plant and defective tires from its Waterville plant. Total yearly net revenue from these three sources would not exceed $24,000. The volumes of these wastes from Michelin are expected to be not only small, but also inconsistent. Defective tires would also require the removal of steel belting and subsequent shredding prior to incineration. The low net revenues generated would not offset the capital costs required for the proper materials handling facilities. The potential for cogeneration revenues to offset these costs is considered in Section 3.0.

Table 2.2 Net revenue for non-hazardous waste by source

Material type	Source and location	Available quantities	Revenue at source ($/t)	Transportation cost ($/t)	Transportation method	Net revenues	Comment
		At present (t)				Total ($)	
Uncured rubber	Granton	5,000	($5)	$21	rail	($130,000)	Not cost-effective
Mined MSW	CBRM landfill	80,000	($10)	$2.5	road	($1,000,000)	Not cost-effective
Uncured rubber	Waterville	5,000	($5)	$66	road	($355,000)	Not cost-effective
Uncured rubber	Bridgewater	5,000	($5)	$66	road	($355,000)	Not cost-effective
		95,000 t				($1,840,000 t/yr)	
		Annual (t/yr)				Annual ($/yr)	
Defective tires	Granton	300	$80	$21	rail	$17,700	Volume very small
Uncured rubber	Granton	250	$35	$21	rail	$3,500	Volume very small
Defective tires	Waterville	300	$80	$71	rail	$2,700	Volume very small
Defective tires	Bridgewater	300	$80	$84	rail	($1,200)	Not cost-effective
Coal rejects	Donkin	40,000	$0	$4	road	($160,000)	Not cost-effective
Coal rejects	CBDC	33,000	($6)		inc.	($181,500)	Not cost-effective
Uncured rubber	Waterville	270	$35	$66	road	($8,370)	Not cost-effective
Uncured rubber	Bridgewater	250	$35	$66	road	($7,750)	Not cost-effective
Raw MSW	CBRM	50,000	($5)	$2.5	road	($375,000)	Competes with CBRM
Pallets	Granton	230	$0	$37	rail	($8,510)	Not cost-effective
Wood waste	Gammco	6,500	($6)	$37	rail	($279,500)	Not cost-effective
Wood waste	Jullmar	6,500	($6)	$37	rail	($279,500)	Not cost-effective
Pallets	Waterville	230	$0	$71	rail	($16,330)	Not cost-effective
Pallets	Bridgewater	230	$0	$71	rail	($16,330)	Not cost-effective
		138,360 t/yr				($1,318,890)/yr	

2.4 Hazardous Waste Materials

Potential hazardous materials include contaminated soil, sludge and sediment, waste oil, organic solvents and treated wood. The community focus in Sydney is on the contaminated sites and other pollution problems in the Muggah Creek watershed area. The elimination of these concerns is JAG's priority. Support for the importation of hazardous wastes to Sydney for destruction at the FBC facility, even with significant revenue generation, is currently unlikely. In addition, private sector alternatives exist in Nova Scotia for disposal of most types of hazardous waste. Treating these at the FBC facility could be viewed as government-supported competition. As a result, while hazardous waste sources throughout the region were identified by JWEL for the purposes of completeness and comparison (Appendix 2, Table A2.2), sources outside Cape Breton are summarized in Section 2.5 but were not considered as currently viable alternatives for the FBC facility.

2.4.1 Cape Breton Hazardous Waste Sources and Market Factors

A number of significant sources slated for future remediation would be amenable to incineration:

- Sydney Tar Ponds: 655,000 tonnes in situ of PAH contaminated sludge/sediment
  45,000 tonnes in situ of PCB contaminated sludge/sediment (Section 2.5)
- Coke Ovens Site Domtar tank: 5,300 tonnes of hydrocarbons and PAH contaminated sludge
- Domtar Tar Cells: 600 tonnes of PAH contaminated sludge from off-spec tar disposal
- Coke Ovens Benzol Tank: 200 tonnes of hydrocarbon contaminated sludge
- Four tanks at the SYSCO Tank Farm #2: 6,400 tonnes of hydrocarbon contaminated sludge
- Coke Ovens area: possibly up to 1 million tonnes of sediment and soil with mixed contaminants
- Drilling muds from offshore oil production (hydrocarbon and barium contamination)
- Numerous petroleum hydrocarbon contaminated sites in Cape Breton (assume 10,000 tonnes/year)

Several factors may limit the volumes available for incineration. Hydrocarbon contaminated material is still accepted by at least 10 landfills in Nova Scotia, including the CBRM landfill. Tipping fees are generally low or even non-existent. At the CBRM landfill, tipping fees are $50/tandem truck and $75/trailer, roughly equivalent to $2-$3/tonne. A growing number of dedicated facilities for contaminated soil disposal operate in Nova Scotia. These generally treat soil by bioremediation (light hydrocarbons only), low temperature thermal desorption or landfarming. Tipping fees are typically $45-$65 per tonne. While there is no current facility in Industrial Cape Breton, an application has recently been submitted to establish one in Sydney. The Atlantic Provinces are working to produce a harmonized procedure for contaminated site management that will be more site specific and risk-based, and may result in less contaminated soil requiring off-site disposal. All sources are carried for the revenue analysis except drilling muds. Sable Offshore Energy Project (SOEP) have already received Tenders for disposal of wastes and expect to award a contract shortly.

Table 2.3 summarizes information on hazardous feed materials.

Table 2.3 Summary of Hazardous Feed Materials

Waste material and source	Quantity (tonnes)	Market factors	Major public perception issues ?	Major competition issues ?	Major recycling issues ?	Suitable for FBCs ?
Contaminated sediment/soil/ sludge						
Sydney Tar Ponds (PAH sediment)	655,000 total in situ	Alternative remedial options available (but may not be cost effective or publicly acceptable). Existing permit to burn this material.	Yes	No	No	Yes
Coke Ovens Domtar tank	5352 total	Material slated to be remediated through JAG mandate.	Yes	No	No	Yes
Domtar tar cells	600 total	Material slated to be remediated through JAG mandate.	Yes	No	No	Yes
Coke Ovens benzol tank	200 total	Material slated to be remediated through JAG mandate.	Yes	No	No	Yes
SYSCO Tank Farm #2	6400 total	Currently no impetus to dispose of material.	Yes	No	No	Yes
Local sites	200,000 total	Soil and sediment with mixed contaminates from Muggah Creek watershed. Quantity assumed for revenue analysis.	Yes	No	No	Yes
Offshore drilling muds	small quantities	SOEP has tenders from private companies to dispose of material. Envirosoil (Halifax) is permitted, has treated Panuke-Cohasset muds.	No	Yes	No	No
Miscellaneous hydrocarbon contaminated sites in CB	10,000/yr	New contaminated sites management approach may allow some material to remain in place. Several private companies have soil treatment facilities in mainland NS or propose facilities in CB.	No	Yes	No	Yes

2.4.2 Potential Revenue

The Nova Scotia Government is responsible as the owner for the Tar Ponds, Coke Ovens site and the FBC facility. Even if provincially budgeted funds were allocated to these clean ups, they would not represent an external revenue source for SERL unless other levels of government assisted with project funding. In this analysis, therefore, it is assumed that there is no external revenue source at this time.

Additional costs would be required for removal (e.g. excavation) and materials handling. For example, past dredging operations at the Tar Ponds have been unable to deliver a continuous feed to the FBC units. Major modifications are required. Most efficient removal and feedstock delivery, and best environmental protection, would result from introducing a large, specialist environmental dredge such as that used at the Bayou Bonfouca Superfund site in Louisiana. JWEL estimates, based on experiences at other major sites such as Bayou Bonfouca, that costs for effective excavation, handling, dewatering and transport of the Tar Ponds sediment could approach $60/tonne. Costs to remove, handle and transport Coke Ovens material (Domtar tank, Domtar tar cells and benzol tank) are estimated to be around $10/tonne. Costs for material from other local sites are estimated to average around $5/tonne.

Potential revenue for other contaminated soil from Cape Breton sites could approach $50/tonne, a competitive rate for soil treatment at other Nova Scotia facilities.

Table 2.4 confirms that with the exception of contaminated soil from other Cape Breton sites (and only if the CBRM landfill ceased taking this waste stream), no positive net revenues are available. The analysis presented in Table 2.4 is the same as that described for non-hazardous wastes in Section 2.3.2.

Table 2.4 Net revenue for hazardous waste by source

Material Type	Source and location	Available quantities	Net revenues	Comment
		Present (t)	Total ($)	
Contaminated s/s/s	Benzol tank	200	($2,000)	JAG seeking disposal; budget in preparation; competitive
	Domtar tar cells	600	($6,000)	
	Domtar tanks	5,352	($53,520)	
	Sysco Tank Farm #2 Tanks	6,405	($64,050)	
	Local sites (Muggah Creek area)	200,000	($1,000,000)	
PAH contaminated s/s	Sydney Tar Ponds	655,000	($36,000,000)	Original FBC waste
		870,000 t	$37,000,000	
		Annual (t/yr)	total ($/yr)	
Contaminated s/s/s	Miscellaneous CB	10,000	$449,000	Competition with other facilities

2.5 Other Waste Streams

Other sources not presently acceptable for the FBC facility include the Tar Ponds PCB sediment and waste from off-island sources. Characteristics are presented in Appendix 2, Table A2.2.

2.5.1 Sources and Market Factors

Tar Ponds PCB-Contaminated Sediment

Following a detailed delineation program by JWEL-IT in 1995-1996, 45,000 tonnes of PCB-contaminated material was identified in the Sydney Tar Ponds. This material is located in seven areas of the North and South Ponds. Other remediation technologies available for consideration include off-site containment, volume reduction and off-site destruction and various on-site destruction methods such as chemical, thermal and biological.

Results of a Public Opinion Survey commissioned by JWEL-IT (conducted by Omnifacts, 1996) indicated that at that time 49% of those asked preferred out of province disposal of the Tar Ponds PCB material; 22% preferred on site incineration, 15% preferred to treat it chemically on site and 7% did not know how it should be treated. Major public involvement would therefore be required before any decision to incinerate these PCB sediments in the FBC facility.

Off-Island Waste

Several sources of waste exist outside of the Cape Breton region. These sources of waste have not been included in the overall revenue analysis as the public would currently be unlikely to support the importation of hazardous waste into Cape Breton. These sources include:

- Former US Naval Facility Argentia, NF
- Contaminated soil from various industrial sites on mainland NS
- Organic Solvents
- PCB sediment/soil from Five Island Lake
- Biomedical waste
- Treated wood
- Waste oil

Details on these sources are presented in Appendix 3.

Table 2.5 summarizes information on waste feed materials from these other sources.

Table 2.5 Summary of Other Waste Feed Material

Waste material source	Quantity (tonnes)	Market factors	Major public acceptability issues ?	Major competition issues ?	Major recycling issues ?	Suitable for FBC ?
PCB sediment/ Sydney Tar Ponds	45,000 total	Alternative (though not necessarily cost effective) in situ and on site remediation techniques available.	Yes	No	No	Subject to public acceptance
Off-Island Waste						
Former USN Argentia - contaminated soil	100,000 total	Remediation alternatives currently being discussed. Planned on-site hazardous waste landfill may take some material.	Yes	Yes	No	No
Misc. industrial sites in NS - contaminated soil	20,000/yr	Potential sites include Amherst Aerospace and Domtar in Truro.	Yes	Yes	No	No
Organic Solvents/ industrial waste	10,200/yr	Disposed out of province by Laidlaw and Philip. Material may be stockpiled by other companies awaiting affordable disposal.	Yes	Yes	No	No
PCB sediment/ Five Island Lake project	sediment: 9000 soil: 3,000 total	Alternative (though not necessarily cost effective) in situ and on site remediation techniques available.	Yes	No	No	No
Bio-medical waste/ Various hospitals throughout Nova Scotia	4000/yr	Currently being incinerated in CBRM incinerators.	Yes	Yes	No	No
Treated Wood/ demolition	100,000 total	Recycled or landfilled - some no longer accept creosote-timber.	Yes	Yes	Yes	No
Waste Oil/ post-consumer waste	10,000,000 L/yr	Used oil collected by government approved collectors. Industrial waste used in boilers or burned on site. Oil from reprocessors is costly.	Yes	No	No	No

2.5.2 Potential Revenue

Tar Ponds PCB-Contaminated Sediment

The Nova Scotia Government is responsible for the Tar Ponds and the FBC facility. It is assumed that removal and disposal of PCB contaminated sediments from the Tar Ponds would be budgeted jointly with SERL operations if FBC incineration were the preferred disposal option for these sediments. It is not appropriate to consider funding for the treatment of these wastes as "revenue", as previously discussed in Section 2.4.2. In this analysis, therefore, only the costs associated with the clean up of the Tar Ponds PCB sediments are considered for these materials.

Additional costs would be required for removal (e.g. excavation) and materials handling. Major modifications would be required to dredging and feed delivery systems. JWEL estimates that the cost associated with the excavation, handling and transport of the Tar Ponds PCB and PAH sediment is likely to be about $60/tonne.

Off-Island Waste

Potential net revenue (after transportation) from these sources, while not carried in the business case analysis, has been estimated by JWEL to be:

Former US Naval Facility Argentia, NF	$6 million total
PCB sediment/soil from Five Island Lake	$4.2 million total
Organic Solvents	$2 million/year
Biomedical waste	$600,000/year
Contaminated soil from various industrial sites on mainland NS	$450,000/year
Treated wood	($50,000/year)
(The cost to transport the wood to Sydney far outweighs the revenue at source)	
Waste oil	($1,500,000/year)
(The cost to acquire oil in a competitive commercial market)	

If community opposition to importation of off-island hazardous wastes reduced in future, and if other factors such as competition with existing facilities were overcome, these waste sources could provide substantial positive net revenue to offset the FBC recommissioning and operating costs. At present neither of these appears likely.

3.0 COGENERATION COSTS AND REVENUES

Several options exist for cogeneration revenue that would reduce net operating costs for the FBC facility. Efficient operation of the FBC incinerators could produce electricity and heat. Since FBC incineration systems require specific operating ranges to be maintained in order to fluidize the circulating beds, electricity and heat production rates are relatively independent of the type of material burned. The available revenue depends upon the production rate for electricity (MWe) and heat (MWt), the ability to use the heat effectively, and the prices (or avoided costs) available for electricity supply and heat use.

About 6 MWe can be generated by the FBC system. The selling price for this electricity would be about $0.029/kWh, giving electricity revenue of $174/hr (6 MWe x $0.029/kWh x 1000). A maximum plant capacity factor of 80% would provide monthly revenues of $102,000 and annual revenues of $1,220,000.

Revenue generation from heat in the incinerator flue gas is more difficult to assess. Possibilities include transfer of this energy to a water cooling system or to a gas cooling system. Unless significant improvements are made to the existing boiler, revenue from steam production should not be considered. An air-based regenerative heat exchange process would provide two options: return the heated air to the process to pretreat the feed stock or incoming combustion gases; or dilute the heated air and use it for alternative purposes such as drying, heating or even greenhouses. A two stage process could combine these uses for maximum efficiency. Basic installed costs for such a system would approach $2 million. CETC suggests 13 MWt could be expected from the FBC system with 'revenue' effectively generated at a rate of $0.0089 (0.89cents) /kWh. A lower value of 8 MWt should be used until recommissioning approaches have been confirmed and options for use of the thermal energy can be determined with more reliability. The revenue available from this source is therefore $71/hr (= 8 MWt x $0.0089/kWh x 1000). A plant capacity of 80% would result in monthly revenues of $42,000 and annual revenues of $500,000.

Under the trial recommissioning scenario equipment modification costs to utilize thermal energy would not be justified. The reliability of the system would be poor, with capacity factor closer to 50%, further reducing the value of intermittent power generation. For trial recommissioning, no revenue from cogeneration should be assumed. Following an aggressive recommissioning, including equipment to utilize the thermal component, effective revenues could rise to $144,000/month or $1,720,000/year. These would offset monthly operating costs.

Section 2.3.2 concluded that operating the FBC facility with non-hazardous waste would produce only $24,000 of direct revenue per year. This revenue alone would not justify the capital costs required for appropriate materials handling facilities. The combined revenue from cogeneration and net "tipping fees" would offset little more than 20% of annual operating costs.

Non-hazardous wastes should therefore not be considered in recommissioning the FBC facility.

4.0 COSTS FOR RECOMMISSIONING AND OPERATION

At the time of original system design in 1985 -1987, the net cost for the Sydney Tar Ponds clean up project was estimated to be about $7 million. By 1993, with the FBC facility constructed and capital costs at $49 million, the projected total project net cost had increased to about $87 million.

The primary reason for the increase over this ten year period was that the original project concept had envisaged the operation as an add-on to the operating SYSCO power plant, with significant revenues from power generation subsidizing project operations. This cogeneration potential was realized to be unrealistic by the time the FBC facility was constructed in 1993, due in part to changes in the operation of the SYSCO steel plant.

Prior to taking over the FBC facility in 1994, STPCUI had assumed an operating budget of $7 million per year for 10 years to treat the Tar Ponds sediment. Including the costs already incurred by this time (close to $60 million) this implied a total project cost of about $130 million, less any cogeneration revenue that could eventually be realized.

A team of specialists was commissioned by STPCUI to conduct a technical review of the project in 1993/94. Although the study report did not focus on project costs directly, it presented information provided by the previous project manager. Capital costs to project completion were projected to be $56.5 million, an increase of $32.1 million from the original 1985 estimate of $24.4 million. Operating costs (net of cogeneration) were projected as $47.7 million, an increase of $65.2 million from the $17.5 million earnings estimated in 1985.

The report therefore estimated, on the basis of this information from the project manager, that the total project cost might be $104 million, with $52 million remaining to be expended at May 1994. It should be noted that these estimates did not include any costs necessary to remove and dispose of the PCB contaminated sediment in the Tar Ponds. However the report pointed out that since successful operations had never been achieved it was difficult to assess an appropriate level for contingency allowances. It also noted that operating cost estimates were particularly sensitive to the throughput rates eventually achieved.

The report also compared these cost estimates to typical industry costs for other hazardous waste management facilities. It noted that if the projected project costs were correct the FBC facility would have a total unit cost of $149/tonne of sediment remediated, "significantly below typical reported costs for other decontamination treatment systems" which ranged from $120 to over $2,000/tonne.

During 1995, JWEL-IT carried out detailed evaluations of the conditions of the FBC facility to determine their condition and applicability for processing the Tar Ponds PAH contaminated materials. This work was reviewed and re-examined in detail on the basis of up-to-date information about the state of the FBC facility.

Other sources of supplementary information included:

- The 1994 report by R.V. Anderson Associates Limited entitled "Review of the Sydney Tar Ponds Sediment Remediation System".

- The 1997 report "Assessment and Recommendations on Preventative Maintenance and Market Value of the Various Assets at the Sydney Tar Ponds Site", by Strum Engineering Associates Ltd.

- A January, 1998 draft Division Report on "A Study on Alternate Uses for the Twin Sydney Tar Ponds FBC Boilers" by D.L. Granatstein and E.J. Anthony of the Combustion Energy Technology Centre, Natural Resources Canada.

- Discussions with a number of present and former personnel associated in various ways with the Tar Ponds project.

Based on this information, detailed requirements and cost estimates were then prepared and reviewed with SERL staff for the two recommissioning scenarios (trial or aggressive recommissioning for hazardous wastes). Recommissioning start up and operating costs were developed separately and are presented in this section as follows:

- regulatory and public acceptability requirements before operations can commence
- modifications required to the FBC incinerators
- modifications or new systems required for materials handling
- residuals (ash) disposal requirements
- operating requirements

The estimated costs, the schedule for each component of work, and the employment created for each phase of work, are summarized in tables at the end of each subsection.

Section 4.6 summarizes all the recommissioning and operating costs for each phase of future recommissioning and operations, from initial regulatory approval activities through physical recommissioning to long-term treatment operations.

4.1 Regulatory and Public Acceptability Requirements

Activities to meet regulatory requirements and address potential public concerns are broken down as follows:

- Environmental Approvals and Environmental Assessment processes
- Testing the FBC incinerators to demonstrate compliance with permit and approval stipulations
- Operational plans for compliance with regulatory stipulations
- Training of labour to meet regulatory requirements
- General site work to comply with standard erosion controls to prevent run-off

SERL (as STPCUI) currently holds an Industrial Waste Permit from the Nova Scotia Department of the Environment to use the FBC incinerators to process the PAH contaminated sediments only. New approvals, under the Approvals section of the Nova Scotia Environment Act, would likely be required to treat other materials in the FBC incinerators, to use significantly different excavation or materials handling processes for the Tar Ponds sediments, or to develop a new residuals disposal facility.

Public demand and various other factors could trigger a requirement to carry out Environmental Assessment (provincial, or joint federal/provincial), especially for materials providing a greater risk to public health or the environment than the PAH sediment (e.g. PCB sediment). The EA process could follow a number of different paths depending on the outcome at each stage and would require full public involvement. It might be possible to exit the assessment process at various early points, with consequently reduced costs, depending on public support for the proposed project.

PCB sediment from the Tar Ponds was assumed not to be part of the initial waste stream intended for the FBC facility, to reduce lengthy delays in the recommissioning process.

It is assumed for costing purposes that the existing Industrial Waste Permit to operate the FBC for incineration of the PAH Tar Ponds materials below 50 ppm PCBs would remain valid (although amended conditions may be applied as approvals are sought for other aspects of recommissioning) but that new environmental approvals would be required for the facility to treat other waste materials.

The costs for activities under the Approvals process would be highly dependent upon the specific requirements imposed by the regulators, which would be largely driven by public acceptance of the proposed recommissioning. These activities would include extensive public involvement.

The regulatory requirements were assumed for the purposes of this preliminary analysis to be the same for either trial or aggressive recommissioning.

The Nova Scotia Labour Act also applies to operation of the FBC incinerators. The Nova Scotia Department of Labour requires specific labour qualifications for operation of the FBC units. These requirements would likely be difficult to meet from the present SERL staff complement or from the available local workforce.

Based on these considerations and the gradual loss of previously trained employees in other areas, extensive training will therefore be required if employment is to remain local. Both the cost of training and extended training schedule have been accounted for in the cost estimation.

Table 4.1 summarizes the likely costs, schedule and employment associated with meeting the anticipated regulatory requirements prior to recommissioning the FBC incinerator system and commencing operations to treat hazardous materials.

Either approach would involve costs in excess of $2 million over a period likely to be about six months (although this could easily be extended by the requirements of the Environmental Approvals or Environmental Assessment processes). About 12 additional jobs would be generated in addition to the current workforce required to maintain the facility.

Table 4.1 Summary of costs associated with regulatory requirements

Item	Trial	Aggressive
Approvals/Assessment	$750,000	$750,000
Testing of fluidized beds	$775,000	$775,000
Plans	$150,000	$200,000
Labour training	$400,000	$400,000
General sitework	$270,000	$270,000
Total cost	**$2,345,000**	**$2,395,000**
Schedule (months)	6	6
Employment	12	12

4.2 Required Modifications to FBC Incinerators

Significant modifications are recommended for the FBC units prior to either trial operations or aggressive recommissioning. However, the level of modifications is dependent upon the desired reliability and operational life of the incinerators. Appendix 4 provides a detailed examination of the present state of the FBC components and identifies appropriate equipment modifications and associated costs, considering the requirements for trial recommissioning (for short-term, temporary operations where lower efficiencies may be acceptable) or for aggressive recommissioning (long-term, where maximum operating efficiencies are required).

For an aggressive recommissioning to allow extended operations, significant improvements to the boiler, generator, support buildings, controls, and utilities should be undertaken. The amount allocated under aggressive recommissioning scenario for the turbine generator ($1,019,000) allows for major refurbishing. It should be noted that this may not be sufficient and at some during future operation a new generator will be required, likely at a cost of $3 million. The costs include an allowance for field and organization staffing during the modification and commissioning period.

Table 4.2 summarizes the likely costs, schedule and employment associated with the modifications that will be required for the FBC incinerators under each recommissioning scenario for hazardous waste.

The equipment modifications required for trial recommissioning would cost about $4 million. An additional $4-5 million (total almost $9 million) would be required for the aggressive recommissioning approach. A substantial part of this extra cost would be associated with the components required for cogeneration.

Most of the modifications could be done in about 4 months, with employment of about 40 personnel under the trial approach or close to 70 for the aggressive approach.

Table 4.2 Summary of Costs Associated with Equipment Modification Requirements

Item	Trial	Aggressive
Engineering design/permits	$861,000	$861,000
Field staffing	$1,751,000	$1,751,000
Boiler repairs/modifications	-	$2,018,000
Condensate pumps/system	$25,000	$25,000
Incinerators	$296,000	$1,196,000
Fuel cells & auxiliary equip.	$5,000	$5,000
Baghouse/Ash handling	-	$122,000
Turbine generator, etc	-	$1,019,000
Electrical & instrumentation	$213,000	$310,000
Cooling water screens	$41,000	$41,000
Powerhouse/aux. buildings	-	$93,000
CEM	$30,000	$30,000
New/mod. of buildings	$248,000	$496,000
Utilities	$41,000	$220,000
Initial spare parts	$571,000	$571,000
Total Cost	**$4,082,000**	**$8,758,000**
Schedule (months)	4	4
Employment	41	69

4.3 Materials Handling

The FBC system is currently configured for feed material from the Tar Ponds, supplemented by coal, however it has never operated on a sustained basis. The failure of the excavating and transfer system to perform reliably and continuously was a prime factor in the 1995 decision to halt the project. Significant modifications to these facilities are required to support sustained operations.

Cost associated with removing the sediment from the Tar Ponds are presented and discussed separately in Section 2.4.2 (Potential Revenue for Hazardous Wastes). Alternative material handling systems would be required for waste types such as dry soil that could not readily be fed to the FBC units utilizing the slurry based system originally installed.

These cost estimates assume the FBC facility is recommissioned to handle soil, sludge and sediment only. The requirements for more flexible material handling facilities would increase as the diversity of accepted waste types and transportation modes increase. Costs include expected requirements for new rolling stock for on-site material handling.

For trial operations, it is assumed that relatively inefficient operations, with frequent shutdowns, would be acceptable and that regulatory restrictions might be relaxed somewhat, but on a temporary demonstration basis only.

Likely materials handling costs, associated schedule and employment are summarized in Table 4.3.

Upgrades to the materials handling system would cost about $1 million for trial recommissioning and an additional $700,000 for aggressive recommissioning.

Most of the upgrades could be done in about 3 months, and much could be done concurrently with the modifications to the FBC units. About 5 persons would likely be employed on these activities.

Table 4.3 Summary of Costs Associated with Material Handling Items

Item	Trial	Aggressive
Non-slurry handling system	$300,000	$300,000
Heavy equipment purchases	$680,000	$1,360,000
Total Cost	**$980,000**	**$1,660,000**
Schedule (months)	3	3
Employment	5	5

4.4 Residuals Disposal

Ash, the major byproduct of FBC combustion, varies with feeds and fuels. The original plan to backfill ash into excavated areas of the Tar Ponds could be used if this sediment were an early waste stream. A new permitted landfill would otherwise be required for long-term ash disposal. The "LeVatte Pit" in the slag area near the incinerators is no longer used. It has substantial storage capacity and may offer a good potential location for a residuals disposal facility subject to regulatory approval. It is assumed that leachable metal content or other residual contamination would not require the ash itself to be designated a hazardous waste. Residual contamination is usually more problematic from municipal or mixed waste feeds than from high thermal content organic feeds, due to the presence of metals in batteries and other household products.

Nova Scotia Power Incorporated (NSPI) operates an ash disposal facility in conjunction with its power generating plant in Point Aconi, Cape Breton. As the capital costs associated with the development of ash disposal facilities are quite high and the capacity of this facility is limited, NSPI is currently looking for alternative uses of its ash. NSPI is therefore not interested in taking ash from the SERL FBC incinerators, even for a tipping fee. In addition, the possibility that ash from the FBC incinerators might be derived from hazardous, unknown or inconsistent wastes makes it even less acceptable to NSPI. Cape Breton Regional Municipality disposes of ash from its incinerators in a section of the Sydney landfill. Available space is limited and the Municipality may soon be seeking approvals to extend the ash landfill area or create a new residuals facility. For short term or trial operations, it is nevertheless assumed that the ash will be disposed of at the Sydney landfill. These tipping fees have been included as operating costs (in Section 4.5) rather than as start-up costs for trial recommissioning. All trucking is also included in the operating costs.

The cost for landfill construction is estimated to be about $500,000 under the aggressive recommissioning approach. This is the estimated cost to establish a dedicated landfill with limited initial capacity. Costs associated with the required expansion of the landfill are shown as operating costs in Section 4.5.

During the initial operation of the incinerators, Environment Canada required an enclosed facility for ash handling prior to disposal. The building previously used has been removed during recent decommissioning operations in the area. A replacement facility will be required.

The anticipated costs, and the associated schedule and employment during landfill construction, are shown in Table 4.4.

Table 4.4 Summary of Costs for Residuals Disposal

Item	Trial	Aggressive
Landfill construction	-	$500,000
Total cost	-	**$500,000**
Schedule (months)	-	5
Employment	-	10

4.5 Operating Costs

This report attempts to segregate fixed costs from ongoing operational costs. For simplicity, operational costs for most items are assumed similar for the trial and aggressive recommissioning options. In reality, the higher capital investment proposed for the long term operations should reduce operational costs by improving reliability of the plant and reducing major maintenance costs. For example, cogeneration would not occur under the trial recommissioning approach. Since the boiler could therefore not be used to assist gas cooling, it would be necessary to vent the steam to the atmosphere. The increased useage of water resulting would add costs to the trial scenario. This level of detail has not been incorporated fully into these estimates but should be considered in more detailed financial analysis once preferred recommissioning scenarios have been selected.

For short-term trial operations ash is assumed to be disposed of at the Sydney landfill. A tipping fee has not previously been negotiated for this significant volume of material. For the purposes of this analysis a cost of $30/tonne of ash has been assumed to cover transportation and tipping fees.

For long-term operations following aggressive recommissioning, operating costs are assumed to include the cost to gradually expand a dedicated ash landfill. Discussions with the CBRM, who have capacity issues at the existing Sydney landfill, could potentially identify alternative options for joint approaches to ash landfilling.

The operational costs for different commissioning options has been adjusted to reflect the requirements for ash disposal, acid gas neutralization and feed sampling. Monthly operating costs are summarized in Table 4.5. Estimates of employment associated with ongoing operations are included.

Table 4.5 Summary of Monthly Operating Costs

Item	Trial	Aggressive
Wastewater treatment 20 gpm	$1,000	$1,000
Coal consumption	$23,000	$23,000
#2 fuel oil	$47,000	$47,000
Limestone	$51,000	$38,000
Electrical	$77,000	$77,000
Spare parts	$16,000	$16,000
Landfill operations/ closure	-	$18,000
Ash t&d (5,000 tons@$30/T)	$150,000	$20,000
FBC operations maintenance	$63,000	$63,000
Ash handling operations	$56,000	$28,000
Air monitoring	$30,000	$30,000
Annual testing of FBC units	$28,000	$28,000
Sampling/analytical of feed	$72,000	$72,000
On-site supervision	$30,000	$30,000
Field staffing requirements	$190,000	$190,000
Maintenance staff	$24,000	$24,000
Water bill & office expenses	$20,000	$20,000
Office support	$10,000	$10,000
Ash stabilization (lime)	$3,000	$3,000
Total cost per month	**$891,000**	**$738,000**
Employment	**65**	**65**

4.6 Summary of Costs for Recommissioning and Operations

Total costs for all recommissioning activities and for ongoing operations under trial or aggressive recommissioning are summarized in Table 4.6.

The estimated start-up costs for recommissioning of the FBC units with hazardous waste are $7.4 million for trial recommissioning and $13.3 million for aggressive recommissioning. FBC equipment modifications are the largest cost component in each case although regulatory requirements and materials handling requirements are both significant. Aggressive recommissioning includes establishing a dedicated ash landfill. The monthly operating cost for trial commissioning is $891,000, including up to $150,000 per month to transport and dispose of ash at an existing landfill. Cogeneration is not available during a trial recommissioning, so that the monthly operating costs are not offset by any significant revenues. This is about 50% higher than the monthly net operating cost of $544,000 following aggressive recommissioning.

Table 4.6 Total net costs for facility recommissioning and operations

Item	Trial	Aggressive
Recommissioning activities		
Regulatory requirements	$2,345,000	$2,395,000
Equipment modifications	$4,082,000	$8,758,000
Materials handling	$ 980,000	$1,660,000
Residuals disposal	-	$ 500,000
Total recommissioning cost	**$7,407,000**	**$13,313,000**
Operations		
Operating costs (monthly)	$891,000	$738,000
Cogeneration revenue	-	($144,000)
Net monthly operating cost	**$891,000**	**$594,000**
Net annual operating cost	**$10,692,000**	**$7,128,000**
Total costs - recommissioning and 2 years of operations	**$28,791,000**	**$27,569,000**
Total costs - recommissioning and 5 years of operations	Trial approach limits effective operations to 2 years maximum	**$48,953,000**
Total costs - recommissioning and 10 years of operations		**$84,593,000**

Although the recommissioning costs alone are higher for the aggressive recommissioning approach, the resulting benefits of the longer-term approach would be very substantial and almost immediate.

The operating efficiencies, and waste throughput rates, would be almost double. Facility down-time and operating costs would be significantly lower, and substantial cogeneration revenues could be realized.

Figure 4.1 compares cumulative costs for the two approaches, from the commencement of recommissioning through a period of operations.

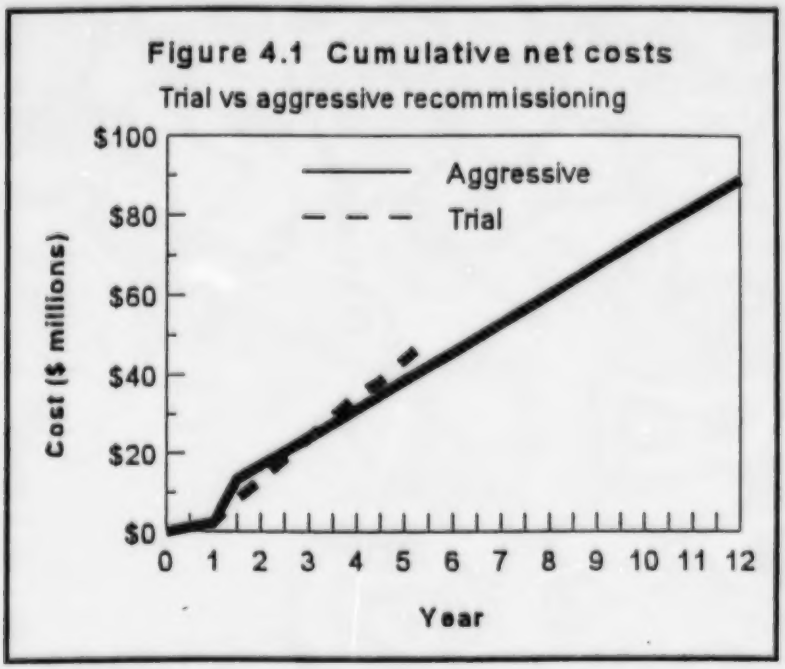

Figure 4.1 demonstrates clearly that after only two years of operations, all the apparent savings achieved up front by the trial recommissioning approach would have been lost. The waste volume treated at this time would be substantially less than for the aggressive approach. Continuing operations beyond this timeframe would also likely require major facility upgrading to sustain effective operations.

The conclusion from the analysis of total costs for the two approaches is that trial recommissioning for temporary operations can not be justified under any scenario or for any available waste type.

If the FBC facility is restarted to treat hazardous waste from the Sydney area, aggressive recommissioning activities should be planned and carried out. These would ensure the facility operated at maximum efficiency, sustainable in the long-term with maximum waste treatment rates and minimum operating costs. An aggressive recommissioning would also minimize the risk of further project setbacks and failures.

4.7 Required Modifications to Support Thermal Destruction of PCBs

There is currently little public support for the incineration of PCB sediment from the Tar Ponds. However it is possible that once clean-up projects in the Muggah Creek watershed are successfully underway, public acceptance could increase for this as a means of closure to the Tar Ponds remediation. Following an aggressive recommissioning of the FBC units, further modifications would still be required to support the thermal destruction of wastes containing over 50 parts per million (ppm) PCBs. These modifications and their associated costs are summarized in Table 4.7.

An Environmental Assessment may be required for the thermal destruction of PCBs. This process could be substantial, depending on public demands. $1.4 million has been allowed to cover these additional regulatory requirements including the assessment process, additional testing of the FBC units and plans.

PCB regulations require that the off gases from combustion of waste containing over 50 ppm PCBs be retained at a required minimum temperature for a minimum duration of 2 seconds residence time. To meet this requirement, a secondary combustion chamber (SCC) would have to be installed in the off gas duct system with supplemental burners.

Further equipment modification costs would be required for additional engineering/design permits. No additional costs would be anticipated for the materials handling or residuals disposal aspects of the operation.

Table 4.7 Added costs to incinerate PCB wastes

Item	Added cost to treat PCBs
Regulatory requirements:	
Approvals/assessment	$1,050,000
Testing of fluidized beds	$260,000
Plans	$50,000
Equipment modification requirements:	
Engineering/design permits	$287,000
Secondary Combustion Chamber	$2,882,000
Materials handling items: no increase	N/A
Residuals disposal: no increase	N/A
Recommissioning costs	$4,529,000
Monthly operating costs	
Sampling/analytical of feed & Ash stabilization	$37,500

Monthly operating costs would increase when treating PCB wastes to cover additional sampling and analysis of the feed and for ash stabilization.

5.0 POTENTIAL LOCAL BENEFITS

Recommissioning and operation of the FBC incinerators to dispose of waste materials would result in many benefits for the Industrial Cape Breton region that would be independent of the direct financial analysis.

5.1 Local Benefits

Although the FBC units could be recommissioned solely to treat non-hazardous waste, undoubtedly the greatest benefit the reactivation of the FBC units can bring to the community is the safe and competent clean up of the contaminated sites in the Sydney area, including the Tar Ponds and Coke Ovens sites. Despite the numerous past and present activities at these sites, no significant contaminant remediation work has been carried out to date.

A particular reason for concern is the potential for ongoing movement of the Tar Ponds sediments into Sydney Harbour. Every year that passes sees a movement of contaminated sediment from the Tar Ponds to the harbour. Several previous studies have used results of suspended sediment monitoring at the mouth of Muggah Creek to estimate the rate of release of PAH from the Tar Ponds to Sydney Harbour. These studies have placed this release in the range 100 - 770 kg/year. At the concentrations of PAH in sediment in the Tar Ponds, this represents the loss of up to 100 tonnes of contaminated sediment every year.

JWEL has previously carried out an unpublished dynamic mass balance for the Coke Ovens Brook - Tar Ponds - Sydney Harbour - Ocean migration pathway for contamination. This work, based on rather sparse data, suggested that past release rates have been up to one hundred times higher than those suggested by the studies above. Although these rates were inferred by JWEL using harbour data when the Coke Ovens were still operating, JWEL considers it is possible that rates comparable to these still occur under some conditions at present.

One possible reason for this discrepancy is that no studies have considered the likelihood of two other mechanisms for release of Tar Ponds sediments to Sydney Harbour. The first of these is apparent when considering that the Tar Ponds sediments do not terminate at the mouth of Muggah Creek, but instead extend well into Sydney Harbour. It is therefore likely that there is some component of slow "creep" of the contaminated sediment mass down and out of the Tar Ponds, then more rapid dispersion by wave and tidal action outside the mouth of Muggah Creek.

The second mechanism is storm flow release of sediment. Muggah Creek drains a large urban watershed with high stormflow peaks. No suspended sediment measurements have been reported at these peaks. It is likely that the low sediment scour and transport rates observed at normal flows are exponentially higher during flood conditions. Delays in activities to prevent further release of Tar Ponds sediments from the Tar Ponds to Sydney Harbour allow the contaminated sediments to continue their free flow into the harbour.

By cleaning these sites, not only will one of Canada's worst contaminated site problems and Sydney's longest standing concerns be alleviated, but the condition of Sydney Harbour around Muggah Creek should also improve dramatically in a short period of time.

Reactivation of the FBC units for the major contaminated sites would also allow the rapid clean up of other smaller quantities of waste and substantially reduce the unit costs for such materials as the contents of the Domtar tank, the Domtar tar cells, the benzol tank and contaminated surficial soil. The remediation of Muggah Creek would also assist more rapid resolution of the sewage problems in the area.

Financial benefits include employment opportunities and additional revenues for local stores and service providers. Indirect benefits of these jobs will accrue to Sydney and Cape Breton.

Clean up of the Tar Ponds and adjacent contaminated sites would be one of North America's major hazardous waste remediation projects and comparable to the largest and most expensive US superfund projects. Any cleanup project of this nature, including a project using the FBC incinerators, would be complex and difficult, as past experience has shown repeatedly. It would be extremely important to optimize operational efficiencies as early as possible in the project, and to maintain them throughout the project. The consequences of not achieving this could be - at best - the addition of many tens of millions of dollars to the ultimate project costs - and at worst another project failure with the project halted and the Tar Ponds and other sites still not cleaned up.

It is therefore likely that irrespective of the waste feed used an experienced thermal contractor, with extensive incineration experience at major contaminated sites, would be required to assist or manage the recommissioning and initial operations. However, this does not in any way preclude the major involvement of local labour, subcontractors and suppliers. Proposals received by STPCUI in 1995 indicated that well over 90% of the jobs created by restarting the Tar Ponds remediation project would be filled by local workers. Expenditures in Cape Breton would be major, with well over 50% of immediate project requirements being met by direct local purchasing of materials and supplies.

The estimated labour force requirements for the FBC incinerator recommissioning and operations are summarized in Table 5.1..

During the recommissioning period of up to 2 years, during which regulatory approvals would be sought and equipment modifications carried out, as many as 84 jobs would exist. Up to 65 full-time positions would be created during the ongoing operations.

Table 5.1 Summary of total schedule and employment for recommissioning and operations

Item		Trial	Aggressive
Recommissioning			
Regulatory activities	*(months)*	6	6
	(employment)	12	12
Other	*(months)*	4	6
	(employment)	46	84
Total duration	*(months)*	10	12
Operations	*(employment)*	65	65

Direct union jobs would coincide with initial building and construction, then with production jobs related to dredging (Tar Ponds), materials handling, incineration, disposal of ash and operation of the power generation facility. Student work term placements could also become an integral component of operations. A number of community programs could be associated very effectively with the operation of the FBC system and its use to remediate local contaminated sites. Such programs might best be created by establishing a long-term, formal partnership between the incinerator operator, the community and UCCB that would include:

- Community liaison and advisory groups
- Elementary school programs
- Community site tours
- UCCB education programs
- Technical training for co-op students associated with health and safety, environmental sampling, air monitoring and QA/QC activities at the facility
- Hazardous waste remediation conferences hosted in Sydney with the FBC system as a central drawcard

Long-term, after completion of remediation projects (15-20 years), the following residual assets would remain for community use:

- creation of a valuable location for further community and business development near the city centre
- facilities left for the community such as a large feed storage building
- equipped site laboratory with trained staff

5.2 Technology Transfer

Technology transfer would occur to the labour force on the project, generating increased potential for long-term economic spin-offs to Sydney and Cape Breton. Areas of specialist technology transfer would include:

- FBC incinerator operation
- Advanced materials handling methods
- "Real-time" air monitoring methods
- Site Health and Safety methods and approaches
- QA/QC methods and approaches
- Data management systems
- Project management methods

If federal and provincial government approved the operation of the FBC units to receive a wide variety of hazardous wastes, including special wastes such as PCBs, a successful industry could be developed and sustained based on the skilled personnel available, providing long-term employment opportunities in the treatment facility.

6.0 SUMMARY AND CONCLUSIONS

The remediation system including fluidized bed (FBC) combustion units, originally designed and constructed for the treatment of sediment from the Sydney Tar Ponds, had not been successfully operated on a continual basis by the time it was transferred to Sydney Tar Ponds Clean Up Inc. (now SERL) in 1994. The FBC units themselves last operated in late 1994 and have been maintained by SERL since then. They are now deteriorating rapidly. SERL currently has three options:

- final decommissioning and probable sale of parts for scrap
- complete (and expensive) mothballing
- recommissioning and continued operations

Further delays in decision-making may eliminate the third (recommissioning) option, and the possibility of using the facility in future for treatment of waste from contaminated sites in the Sydney area. At very least recommissioning may cease to be viable without complete replacement of many major parts.

As part of the CANMET Energy Technology Centre's study team commissioned by SERL to evaluate recommissioning options, JWEL has evaluated the commercial case for recommissioning the Sydney FBC facility for a variety of scenarios.

The analysis identified feed materials that might offer revenue to support a stand-alone commercial operation. Other factors were identified that affect the regulatory or public acceptability of bringing these materials to the facility. Two options: trial recommissioning for short-term operations, and aggressive recommissioning for long-term use of the facility, were considered. The start-up and operating requirements for each approach were costed. Use of cogeneration revenues to offset operating costs was included. Based on this analysis, the following general conclusions are evident:

1. Significant up-front work and costs are required to prepare the facility, and associated infrastructure and components, for further operations of any type. All factors affecting a decision to recommission should therefore be reviewed carefully, and in consultation with all stakeholders, prior to decision making.

2. Many areas of present uncertainty could affect the validity of any decisions made on the basis of this business case analysis. These uncertainties should be examined in detail prior to, and again at the time of, making a final decision on the future of the FBC facility.

3. Recommissioning is viable if, and only if, the FBC facility is to become an integral component of future hazardous waste clean-up in the Sydney area. The technology remains among the best and most cost-effective for providing a permanent solution to the problems that have remained unaddressed in Sydney for many years. Many direct and indirect benefits would result from their use for this purpose.

The following specific conclusions from the business case analysis lead logically to the general conclusions and to JWEL's recommendations:

1. Public support for importation of off-island hazardous wastes to Sydney for destruction at the FBC unit, even if these were revenue-generating, would be low.

2. After deducting transportation costs from "disposal fee" revenue, no non-hazardous waste source could provide a significant positive revenue for the facility.

3. Cogeneration revenues would not support a stand-alone commercial case for recommissioning.

4. **Recommissioning is therefore only justified if it is for the original intended purpose of the facility - to treat hazardous waste from local contaminated sites.**

5. "Special" wastes in the Sydney area, such as PCBs, could probably be destroyed successfully and safely by the modified FBC units, but public support for PCB incineration is currently weak.

6. Successful operation to verify design assumptions had not been achieved when STPCUI took over the facility in 1994. Previous cost estimates for the Tar Ponds project were too low.

7. Significant work is required to recommission the FBC facility for sustained, efficient operations without risk of further project failure. Regulatory activities and facility modifications would take up to a year. This could be substantially longer if environmental assessment activities were required.

8. Trial recommissioning would cost about $7 million, with annual operating costs about $10 million but with low waste treatment rates and high risk of ongoing major shutdowns. Costs to excavate and transport waste to the facility are separate and may be significant, e.g. for the Tar Ponds.

9. Aggressive recommissioning would cost about $13 million, but would result in lower operating costs of $7 million per year, with high sustained treatment rates and minimal risk of project failure. After less than two years of operation the aggressive approach would have lower total costs.

10. **Trial or temporary recommissioning is not justified under any scenario.**

11. **Aggressive recommissioning would produce a viable treatment facility that would be ideally suited to destroy the large hazardous waste volumes present in the Sydney area.**

7.0 RECOMMENDATIONS

1. A decision on the future of the FBC facility should be made as soon as possible during 1998 since delays will lead to serious further deterioration of the facility that may eliminate recommissioning as an option.

2. Since the only viable future use of the facility is for thermal treatment of hazardous wastes in the Sydney area, the findings of this report should be provided to the Joint Action Group and other stakeholders responsible for advising Government on preferred remediation options for these contaminated sites. SERL should promote active discussions to determine the level of community support for the FBC facility as the primary component in these clean-up operations.

3. If this support is not evident, SERL should decommission or mothball the facility during 1998.

4. If use of the facility is supported, SERL should follow an aggressive recommissioning approach. This should include all the upgrading and equipment modifications required to sustain long-term operations with maximum operating efficiencies. This work should commence during 1998 to avoid further facility deterioration.

5. An operational plan for the removal of wastes from sites in the area and delivery to the FBC facility should be prepared prior to recommissioning and adopted by all stakeholders, to ensure maximum efficiency can be achieved in facility operations.

The FBC facility, properly modified and operated, is ideally suited for destruction of hazardous soil, sludge and sediment from the contaminated sites in the Muggah Creek area. However successful recommissioning and operation of the facility for these wastes, including clean-up of the Sydney Tar Ponds, would be one of the largest and most complex remediation projects ever undertaken. Expertise exists from thermal remediation contractors who have completed projects of similar complexity and at similar sites. Taking advantage of this experience would maximize the benefits to SERL and the Sydney Community as clean-ups moved quickly to reality. Many other direct local benefits would also accrue through the project.

Although commercial operation of the FBC facility would initially appear attractive to many commercial operators, the complexity of the project brings a proportionate level of risk - of both project and financial failure - to all parties involved. After several previous failures to proceed to completion, any future decisions should only be made following full analysis by SERL, in consultation with JAG and other stakeholders, of all the factors and uncertainties identified in this report.

Recommissioning and operation of the FBC facility to destroy the hazardous wastes in the Sydney area, if chosen and carried out successfully, would represent a landmark in the remediation of major contaminated sites.

8.0 CLOSURE

This report has been prepared for CANMET Energy Technology Centre as part of a study commissioned from CETC by Sydney Environmental Resources Limited. Any use that a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third party. JWEL accepts no responsibility for damages, if any, suffered by any third party resulting from decisions made or actions based on this report.

JWEL derived some information presented in this report from existing documents and interviews. Although we attempted, whenever possible, to obtain a minimum of two confirmatory sources of information, in certain instances JWEL has been required to assume that the information provided is accurate.

Estimates provided for potential revenues and costs associated with recommissioning and operation of the FBC facility are Treasury Board Class "C" *"conceptual stage estimates based upon the optimum economical solution for investment decision making."* JWEL accepts no responsibility for damages suffered resulting from use of or reliance upon any of the cost estimates provided.

Should additional information become available, JWEL requests that this information be brought to our attention so that we may reassess the conclusions presented herein.

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APPENDIX I

BACKGROUND TO THE FBC INCINERATION PROJECT

1. History of the Sydney Tar Ponds Clean Up Project

The Sydney Tar Ponds, originally known as Muggah Creek, are a 33 hectare tidal estuary of the South Arm of Sydney Harbour. Effluent from the adjacent coke ovens and steel plant during 90 years of operation filled the estuary with 700,000 tonnes of contaminated sediment. The main contaminants of concern are polynuclear aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs).

Investigations from 1981-1985 characterized the release of contamination from the Sydney Tar Ponds and its migration to biota and sediment in Sydney Harbour. In 1986, the Federal Government of Canada and the Province of Nova Scotia entered into an agreement to clean up the Tar Ponds, recognizing that they were one of Canada's largest and most serious hazardous waste sites. The original clean up concept consisted of damming the South Pond, dredging the contaminated material from both ponds and transporting the sludge via a one-mile pipeline for dewatering and water treatment. The contaminated sediment would then be destroyed in two circulating fluidized bed incinerators.

Phase 1 of the project, including design, engineering and construction of the FBC incinerator facility and associated infrastructure, occurred from 1987-1993 under the direction of a joint federal/provincial management committee. The plant was started up, including short-term trial burns with stack emissions testing, and in 1994 was handed over to Sydney Tar Ponds Clean-Up Incorporated (STPCUI), a Provincial Crown Corporation newly created to manage Phase 2 (the operational phase) of the clean up. A number of major operational problems immediately became evident, particularly involving the dredging operations and transfer pipeline. Because of mounting costs (exceeding $50,000,000) and the lack of sustained demonstrated performance, the original project was halted by SERL early in 1995.

As part of its due diligence process prior to taking over the facility STPCUI commissioned a review by R.V. Anderson & Associates Inc. This review concluded that the plant was approaching readiness for operation, although significant work was still required especially in the areas of excavation and transfer of sediment to the fuel storage building and that a significant monetary contingency should be carried.

In mid 1995, STPCUI issued an international call for Statements of Qualifications from experienced private sector operators interested in submitting performance-based tenders to complete the Tar Ponds clean-up. Thirty-eight responses were received from consortia world-wide, including the world's most experienced thermal remediation companies with combined experience in destroying many millions of tonnes of hazardous waste by incineration. Following a rigorous review process STPCUI selected a short-list of three and asked them to submit competitive, performance-based tenders for the clean-up. Prices from these three world-leading thermal remediation companies to complete the FBC incineration project are understood to have ranged up to $185 million, although it should be noted that the three contractors had been requested to exclude cogeneration revenue from their pricing.

One of these three was "JWEL-IT", a joint venture of Jacques Whitford Environment Limited (JWEL) and International Technology Corporation. JWEL is a Nova Scotia based international environmental consultant. IT Corporation, the leading US remedial design contractor and the world's most experienced thermal remediation contractor, has successfully completed more hazwaste thermal remediation than all other North American contractors combined, including similar projects to the Sydney Tar Ponds, and high profile "Superfund" projects in residential areas such as at Times Beach, Missouri and at Bayou Bonfouca, Lousiana. In late 1995 JWEL-IT was selected as the contractor for the Tar Ponds clean-up.

2. The 1996 Muggah Creek Clean Up Project

A JWEL-IT team of fifty remediation experts had spent six months during the proposal period evaluating remediation options - bioremediation, thermal, reduction, solvent washing, containment, solidification, encapsulation, and emerging hybrid technologies. As a result of this work JWEL-IT's tender proposal had offered STPCUI the four most viable clean-up options. Each option represented an effective environmental solution, but the four options provided varying degrees of permanence and contaminant removal from the environment, different timescales for completion, and a range of total costs:

1. Dredge, and incinerate using only the existing FBC incinerators, with an implementation schedule designed to satisfy the Province of Nova Scotia's apparent cashflow availability envelope.

2. Dredge and incinerate using the existing FBC incinerators, and adding a supplementary thermal unit that had been proven on U.S. superfund sites, to reduce the clean-up timeframe to 7 years, and as a result reduce the costs below Option 1 by about $30 million.

3. Dredge all sediments, with landfilling of the PAH sediments in a new, state-of-the-art secure landfill off-site, and either incineration or out-of-province disposal for the PCB sediments, offering substantial cost reduction from thermal options and with all clean-up work completed by 1998.

4. Contain the PAH sediments in situ using an engineered cover with a dam and control structure at the mouth of Muggah Creek. Excavate the PCB sediments for either incineration or out-of-province disposal, with further cost reduction and with all clean-up work completed in 1997.

Following detailed further review of the technical effectiveness of the four approaches offered by JWEL-IT, STPCUI selected JWEL-IT's fourth clean-up option (in situ containment). In January 1996 STPCUI awarded a contract to JWEL-IT for this option.

The first phase of the JWEL-IT work required confirmation of the location and total volume of PCB contaminated sediment at concentrations greater than 50ppm, which was all to be removed. Previous work had suggested this comprised substantially less than 20,000 of the total 700,000 tonnes of contaminated sediment in the Tar Ponds.

The JWEL-IT investigations immediately encountered a number of zones of PCB contamination that had not previously been identified. The first phase of further delineation revealed that the amount of PCB contamination exceeding 50 ppm in the Tar Ponds was over 45,000 tonnes following the first phase of containment project, with one zone of PCB sediment at concentrations greater than 50 ppm extending out from the mouth of Muggah Creek into the harbour and still not delineated. This increase in PCB quantity created a major, unplanned increase in the total clean-up cost. This factor, together with public opposition to in situ containment of the PAH sediments and renewed interest by the Federal Government in the project, resulted in the in situ containment plan, and JWEL-IT's contract, being placed on hold in August 1996.

3. Current status of clean up projects and use of the FBC incinerators

As a result of community initiatives and renewed Federal, Provincial and Municipal Government interest, complemented by a broad range of area residents, a Joint Action Group (JAG) was established in August 1996 to make advise and recommendations to the three levels of Government on the Tar Ponds clean up and other Muggah Creek watershed contaminated site concerns - including the coke oven site, contaminated soil in Whitney Pier, and the cancer/epidemiological study. The JAG has worked actively since then to address these issues. No decisions have been made about clean up technologies and JAG is developing a technology evaluation process to ensure all appropriate technologies are identified and reviewed. Incineration is understood to remain as a possible option, or partial option, at present.

In the meantime, STPCUI, now renamed Sydney Environmental Resources Limited (SERL), continues to provide security for the site incineration equipment and technical assistance to the community as it seeks consensus through the JAG on an action plan.

The SERL maintenance and security program was examined for effectiveness and recommendations were provided to SERL in a report titled "Assessment and Recommendations on Preventative Maintenance and Market Value of the Various Assets of the Sydney Tar Ponds Site" by Strum Engineering Associates Ltd., April 1997. The Strum report identified that parts of the incinerator plant and/or specific components of well defined sub-systems have limited market appeal and consequently are reasonably valued at less than $1 million. The rapid deterioration of the facility and limited availability of options led to the commissioning of CANMET's Energy Technology Centre to investigate recommissioning options. This report forms part of that study.

APPENDIX II

SUMMARY OF FEED MATERIAL CHARACTERISTICS

Table A2.1 Summary of Non-Hazardous Feed Material Characteristics

Type	Source	Quantity (tonnes)	Characteristics
Rubber Waste			
Uncured (green) rubber	Michelin landfilled	770/yr 16,000 total	▸ LHV = 28-37 MJ/kg ▸ 1-1.5% sulphur
Defective tires (scrap rubber)	Michelin	900/yr	▸ LHV = 28-37 MJ/kg ▸ 8-20% ash ▸ 1-1.5% sulphur
Municipal Solid Waste			
"Raw" MSW	Cape Breton Regional Municipality	50,000/yr	▸ LHV = 9.0 MJ/kg ▸ 15-30% ash
Mined MSW	Cape Breton Regional landfill	85,000 total	▸ LHV = <9.0 MJ/kg ▸ 15-30% ash
Coal Rejects	Cape Breton Development Corporation- coarse/fines	33,000/yr	Coarse: ▸ HHV = 5.4 MJ/kg ▸ 12.8% ash ▸ 2.25% sulphur ▸ 70% moisture Fines : ▸ HHV = 10.9 MJ/kg ▸ LHV = 6.75 MJ/kg ▸ 60% ash ▸ 5-7% sulphur ▸ 30% moisture
	Donkin	40,000-80,000/yr	▸ HHV = 20 MJ/kg ▸ 38% ash ▸ 12.4% sulphur ▸ 10% moisture
Wood Waste	Julimar Lumber	6,500/yr	▸ HHV = 21 MJ/kg ▸ LHV = 9 MJ/kg
	Gammco	6,500/yr	▸ 1.5% ash ▸ 40-50% moisture
Pallets	Michelin	700	assumed same as above

Table A2.2 Summary of Hazardous Feed Material Characteristics

Type	Source	Quantity (tonnes)	Characteristics
Contaminated sediment, soil and sludge	Sydney Tar Ponds PAH sediment	655,000 total	▸ HHV = 19-23 MJ/kg ▸ 32-42% ash ▸ 26-30% volatiles
	Coke Ovens Domtar Tank	5352 total	Sludge: ▸ HHV = 34 MJ/kg ▸ 20% moisture Soil: ▸ HHV = 17 MJ/kg ▸ 24% moisture
	Domtar tar cells	600 total	Unknown; testing required
	Coke Ovens benzol tank	200 total	Unknown; testing required
	SYSCO Tank Farm #2 Tanks	6400 total	▸HHV = 10-35 MJ/kg
	Local sites (Muggah Creek watershed)	200,000 total	Unknown, testing required
	Misc. contaminated sites in CB	10,000/yr	Unknown, testing required
PCB contaminated sediment and off-island waste			
PCB contaminated sediment	Sydney Tar Ponds	45,000 total	▸ HHV = 19-23 MJ/kg ▸ 32-42% ash ▸ 26-30% volatiles
Off-Island Waste	Former USN Argentia - contaminated soil	100,000 total	Unknown; testing required
	Misc. contaminated industrial sites in NS	20,000/yr	Testing required
	Organic Solvents/ Industrial waste	10,200/yr	▸ LHV = 40 MJ/kg ▸ low ash content
	Five Island Lake-PCB sediment and soil	sediment: 9,000 total soil: 3,000 total	Unknown; testing required
	Biomedical Waste - various NS hospitals	4000/yr	Unknown; testing required
	Treated wood - demolished buildings	100,000/yr	assumed as for conventional wood waste
	Waste oil -post-consumer waste	10,000,000 L/yr	▸ LHV = 40 MJ/kg ▸ <1% ash

APPENDIX III

OFF-ISLAND WASTE BACKGROUND INFORMATION

Former US Naval Facility Argentia, NF

Approximately 100,000 tonnes of soil contaminated primarily with hydrocarbons is slated for remediation over the next several years. Public Works and Government Services Canada is currently seeking input on the construction/installation of a central, on-site treatment facility for contaminated soil from this site.

The estimated revenue of contaminated soil from Argentia is $70/tonne. This is competitive based on the limited disposal options in Newfoundland, but excludes transportation costs. A cost of $10.50/tonne has been estimated by JWEL to barge the contaminated soil from Argentia to Sydney. This cost includes marine and cargo insurance appropriate to the cargo. Additional handling costs would be incurred for on and off-loading in Argentia and Sydney.

Industrial Sites, Mainland Nova Scotia

There are numerous contaminated industrial sites in Nova Scotia slated for remediation. These include Amherst Aerospace and Domtar, Truro. It is assumed that as much as 20,000 tonnes/year could be generated by these sites. Potential revenue for contaminated soil from industrial sites in Nova Scotia is estimated to be $50/tonne. This is a competitive rate for soil treatment at Nova Scotia facilities.

Organic Solvents

Organic solvents include chemicals such as benzene, toluene, acetone, varsol and other petroleum distillates. In 1982, 10,200 tonnes of "Solvents and Organic Solutions" waste was generated in Nova Scotia. Michelin alone produces 20 to 25 45-gallon drums of solvents a year. This waste stream is currently disposed of on a competitive commercial basis by waste handlers such as Philip Environmental (Atlantic) Ltd and Laidlaw Environmental Services Ltd. These companies generally transport this waste from the Atlantic provinces to Quebec and Ontario for incineration or reprocessing and may have an interest in disposal at the FBC units. Envirosystems, in Dartmouth, Nova Scotia, reprocesses waste organic solvents. This facility currently does not operate at full capacity, possibly confirming a very competitive marketplace.

To be competitive with local waste disposal companies, it is estimated that revenue from organic solvents would not exceed $250/tonne.

Five Island Lake PCB-sediment

PCB contamination exists at the site of the former Associated Metals and Electronics Salvage Yard (AMESY) at Five Island Lake, approximately thirty kilometres south of Halifax. Offsite impacts have also been identified, including sediments in Five Island Lake. Quantities of contaminated material

include 9,000 tonnes of sediment and 3,000 tonnes of soil currently stored on site in trailers. Nova Scotia Department of Transportation and Public Works are currently developing removal and disposal methods for the lake sediment as well as the disposal of the stored material. It is estimated that the work will be undertaken over several seasons. Nova Scotia Department of Transportation and Public Works currently proposes to remove and dispose of stored soil in containers at Five Island Lake in 1998, followed by removing, drying and disposing of sediment from the most highly contaminated area of the lake from 1999 to 2001.

Competitive costs for alternative disposal options currently available suggest the budget required for treatment of this material, is about $260/tonne for the soil and $360/tonne for the sediment. Since the Five Island Lake clean up work is budgeted and planned to proceed independently of SERL or any other Sydney projects, the funding for the disposal of Five Island Lake soil and sediment can effectively be considered equivalent to "revenue" for SERL's FBC incinerators. However it must be noted that while this source is shown as revenue for the purposes of this business analysis for SERL, this revenue does not exist in reality for the Nova Scotia Government, who is the ultimate owner of both projects.

Biomedical Waste

Biomedical waste from provincial hospitals is currently shipped to Sydney and disposed of in the Cape Breton Regional Municipality's incinerators. The incinerators accept approximately 4 trailers of waste per week. This could result in as much as 4000 tonnes/year. Although test burns were conducted and the Nova Scotia Department of the Environment issued an Environmental Approval for the facility, incineration of this waste continues to be the topic of significant public debate in Sydney. There is also a competition issue when considering biomedical waste as a potential source since disposal of this material represents revenue for the Cape Breton Regional Municipality.

Information on precise volumes and current revenues associated with disposal of biomedical waste at the CBRM incinerators is not available. JWEL inquiries and research suggests that based on the likely volumes and typical prices for this type of waste, revenues for incineration are in the order of $185-190/tonne.

Treated Wood

Rail ties, generally treated with creosote, are banned from some landfills in Nova Scotia. Incineration of waste creosote timber and wood products treated with pentachlorophenol may become increasingly viable as landfills refuse to accept this material. About 2500 wooden structures in Nova Scotia contain creosote-impregnated timber. A simple assumption that these are 370 m^2 (4000 ft^2) suggests these buildings might provide as much as 100,000 tonnes of treated wood waste, assuming

that all 2500 building are demolished during the operation of the incinerators. Private construction and demolition debris recyclers operate in Nova Scotia. Some of the material is suitable for reuse or in landscaping applications. Both competition and recycling versus incineration issues are associated with this material.

To be competitive with construction debris disposal facilities in Nova Scotia, it is estimated that revenue from treated wood would not exceed $50/tonne.

Waste Oil

Approximately 20 million litres of automotive oil is sold annually in Nova Scotia. Eight million litres is recoverable. Waste oil is also generated at industrial sites, although much of this is used to fuel boilers or is disposed of on-site in small-scale, low-emission waste oil burners. Unprocessed used oil is banned from municipal landfills and incinerators in Nova Scotia. Waste oil from industrial sites not disposed on site is generally removed by a government-approved used oil collector. The infrastructure for handling used oil is well established. Most of the used reprocessed oil available as a secondary fuel for a waste-to-energy incinerator would come at a fairly significant cost from one of the three largest reprocessors of used oil: Inland Technologies Incorporated, Nova Environmental Systems Incorporated (Quantex) or Atlantic Industrial Cleaners. Inland's annual reprocessed fuel sales are in the order of 10 million litres.

Because reprocessed oil is a viable commodity, reprocessors will charge for the material. Inland has quoted a price of $0.15 per litre ($150/tonne) for delivery to Sydney.

APPENDIX IV

TECHNICAL INFORMATION - EQUIPMENT MODIFICATION REQUIREMENTS

In 1994 and 1995, JWEL-IT, and subcontractors supporting JWEL-IT, inspected the fluidized bed incinerators and supporting equipment for the purpose of determining the operability of the system and the modifications necessary to bring the units online with acceptable reliability. The operational conditions and operational life requirement that was assumed during these inspections was the thermal destruction of the PAH contaminated sediments contained in the Sydney Tar Ponds.

In preparation of this report, the above noted information was reviewed in conjunction with the report prepared by Strum Engineering Associates Ltd. titled *Assessment and Recommendations on Preventative Maintenance and Market Value of the Various Assets at the Sydney Tar Ponds Site*, April 1997. The recommendations included below are generally complementary, and sometimes duplicative, with the recommendations contained in the referenced report. An attempt to capture the combined cost of both sets of recommendations has been made in developing the costing tables.

It is recommended that all of the modifications listed below and in the Strum Engineering report be undertaken for long term operations. Some may be optional for a trial operational period but significantly lower reliability should be anticipated.

Table A4.1 Summary of Costs Associated with Equipment Modification Requirements

Item	Trial	Aggressive
Engineering design/permits	$861,000	$861,000
Field staffing (mob/startup)	$1,436,000	$1,436,000
Field staffing	$315,000	$315,000
Boiler repairs/modifications	-	$2,000,000
Three element controller	$18,000	$18,000
Condensate pumps & system: pump suction strainer	$25,000	$25,000
Incinerators: incineration refractory	$100,000	$1,000,000
FBC operational/reliability/safety	$196,000	$196,000
Fuel cells & auxiliary equipment: Pressurized air line cab	$5,000	$5,000
Baghouse & Ash Handling: Correct fly ash fugitive dust	-	$21,000
Winterize baghouse facility	-	$54,000
Provide integrated ash handling system	-	$47,000
Turbine generator	-	$1,000,000
Turbine overhead crane	-	$19,000
Electrical & instrumentation systems: Repair UPS invertor for DCS	$213,000	$213,000
Upgrade powerhouse lighting		$28,000
Move coal conveyor panel		$19,000
Upgrade electrical @ transfer station		$50,000
Cooling water screens: replacement	$41,000	$41,000
Powerhouse & auxiliary buildings: repairs to powerhouse	-	$20,000
Upgrade access to incinerator	-	$23,000
Upgrade control & instrument room	-	$50,000
CEM Upgrade	$30,000	$30,000
New/modification of buildings	$248,000	$496,000
Utilities: utilities for support facilities		$179,000
Utility installation	$41,000	$41,000
Initial Spare Parts	$571,000	$571,000
Total Cost	$4,082,000	$8,758,000

Table A4.1 presents the detailed cost estimates for required equipment modification that are summarized in Table 4.2 in the main body of the text.

Boiler and Package Boiler

The following boiler and package boiler items need repair or modification to support routine incinerator operation.

Boiler Casing Air Leakage

Air ingress (leakage) into the modified waste heat recovery boiler, which had been identified as a potential problem, was verified by inspection. The boiler, although well designed and maintained, was initially designed for an operating pressure of 0.5 inches of water column (iwc) vacuum. It is estimated that the boiler will be required to operate at a negative pressure between 1.5 and 3.0 iwc when processing wastes in the incinerators. This higher vacuum will cause a significant deflection or movement in the boiler plates unless repairs are made.

To control the infiltrating air, the 7.62 cm (3-in) retainer strips should be removed, exposing the butt joints of the boiler casing plates; the butt joints should be welded solid or seal-welded; and the retainer strips replaced. A support structure should be designed and fabricated on the exterior of the boiler casing, with supports attached to the outer casing/plates to limit movement. All manways and inspection ports should be inspected for structural integrity and fit, new gaskets should be installed, and maintenance should be performed as needed to ensure a leak-free seal.

Reducing the volume of air leaking into the system will allow more air flow to the fluidized beds, therefore increasing the waste processing capacity.

Three-Element Boiler Controller

The present controller arrangement does not provide for automatic control of the water level in the boiler. SERL should design, fabricate, and install offset pipes to raise the water column elevations, which will allow the water level controller to function as designed. All welds should be x-rayed and the column reinstalled using metal-flex gaskets and high-temperature nuts and bolts.

Possible Erosion of Screen Tubes

Inspections by SERL operational personnel have identified no noticeable erosion of the tubes. A wire installed on one of the tubes to detect erosion was still intact after processing 4,000 tonnes of waste, indicating that erosion should not be a problem for these tubes. The screen tubes should be monitored throughout the duration of operations and, if excessive erosion is detected, protective devices installed.

Ash Buildup in the Bottom of the Boiler

During normal operations, ash tends to build up on the slant tubes located at the discharge point of the ash conveyor. The weight of this slag buildup may cause structural damage to the slant tubes. Based on the previous inspection of the boiler systems, and historical discussions with SERL operations personnel, it is

recommended that SERL install soot blowers in the drag conveyor throat to reduce the buildup of slag. This could be accomplished as follows:

- Reinforce the boiler front and rear water wall support beams, as required, to permit cutting through the beam walls.

- Cut the water wall support webs and install G9B soot blowers with appropriate supports in the ash hopper.
- Pipe 10.55 kg/cm^2 (150 psi) steam from the auxiliary steam header to the soot blowers.
- Cable the soot blower starters and local push-button control station from MCC No. 1 and No. 2.
- Commission the soot blowers.

By procuring, installing, and locating the soot blowers as stated above, SERL could eliminate considerable downtime associated with manually cleaning buildups of ash from the slant tubes at the drag conveyor throat.

Oil Burner Control Upgrade

The package boiler, manually operated at present, provides steam to the plant auxiliaries. To provide a constant and reliable source of steam for the auxiliary equipment, SERL should design and install a boiler control panel with appropriate control logic to modulate the oil flow control valve in relation to drum pressure and automatic stop/start of the boiler. An alarm cable from the package boiler to the distributive control system (DCS) should be installed to act as a package boiler general alarm.

By installing the system described above, SERL can create a reliable source of steam that, unlike the existing system, will not be dependent on constant operator attention.

Boiler Feed Pumps and System

Historically, the feed water pumps and system have contributed to considerable downtime. SERL should provide modifications to alleviate these problems.

Auto Transfer

The current arrangement for the pumps require that one boiler pump be selected and run until a scheduled shutdown or failure occurs. SERL should install a second motor with a starter and power supply so that the two pumps can be changed over without interrupting the fluid beds (shutting down the incinerators). SERL should also install a low-pressure switch on each pump discharge and to tie this signal into the pump control logic in order to provide auto-start capability with these pumps. When the discharge pressure falls to a predetermined set point, the standby pump will then automatically start.

SERL should install an interlock tied to low pump suction pressure so that, if sufficient suction pressure is

not available, the pump will shut down, thereby preventing damage to the pump from cavitation. This switch should also be tied into the pump control logic.

No. 2 Pump Vibration and Flow Capacity

The pump should be checked for compliance with manufacturer's specifications. After all necessary adjustments, repairs, etc. have been made, the pump should be operated and tested to ensure its proper performance.

Instrumentation

Before start-up, all instrumentation on the boiler feed water pumps should be inspected and checked for compliance with process requirements, and to determine that the controls are all operating in accordance with the appropriate codes and standards.

Automatic Recirculation Valves

The automatic recirculation valve breakdown orifice that was previously drilled out to prevent deadheading has been corrected. SERL should inspect this and all other mechanical/electrical devices that affect the operation of this equipment and repair/replace as needed.

Condensate Pumps and System

At the design capacity of the fluid bed incinerators, the required condensate flow has been estimated at 908 ℓ/min (240 gpm). Scale that has accumulated in the condensate collection system could damage the pumps. A small change in the performance of the condensate pumps could impact the deaerator water level, which on low-level will shut down the incinerators. To prevent this, SERL should implement changes in the following areas.

Condensate Storage Tank

The condensate storage tank should be drained, inspected, and cleaned. A boiler water treatment program should be selected and implemented throughout the duration of the project.

Suction Strainers

Suction strainers should be installed in each condensate pump suction. These strainers should be specified in accordance with the pump manufacturer's recommendations.

Condensate Pump Flow Capacity

The condensate transfer pump discharge lines should be reconfigured with appropriate valving to allow simultaneous operation of the pumps, thus ensuring sufficient capacity. The pumps should be tested during commissioning to ensure adequate flows are available. If needed, impeller changeouts/adjustments should be made at this time. One pump has failed and replacement is likely required.

Incinerators

The incinerator were found to be in reasonably good condition. The following modifications were identified to improve throughput capacity and on-line factors.

Refractory and Thermocouples

The refractory through the incineration system should be inspected and repaired, as necessary, prior to start-up. The refractory inspection and repair should include the fluid beds and the refractory-lined ducts to the boiler. All thermocouples should be inspected and transmitters calibrated prior to start-up. Any thermocouples that are inoperative should be replaced.

Bed Level Control

The pressure-sensing lines associated with monitoring the differential pressure across the bed (bed depth or level) fill with solids during operation and result in inaccuracies. SERL should install purge lines with appropriate instrumentation to control the pressure and flow of purge air to the pressure-sensing ports. This will prevent the accumulation of solids in the ports, and ensure an accurate measurement of bed depth.

Freeboard Burners

Slag buildup on the incinerator walls may be the result of an inappropriate air-fuel ratio for the type of burner used. The burner controls should be inspected during start-up and a proper air-fuel ratio established to ensure optimal flame shape and combustion conditions. The burners should be adjusted to prevent localized high temperatures that would create slag.

Fuel Cells and Auxiliary Equipment

The following solutions to the problems identified with the fuel cells and auxiliary equipment are recommended:

Hydraulic Cylinder Shaft

The hydraulic cylinder shafts are distorted and must be replaced. Since the original hydraulic cylinder is no longer manufactured, standard cylinders should be specified and procured as replacements. The connection ends should be removed from the existing cylinders and installed on the replacements. JWEL understands that the problem with the proportional control valve has been corrected by SERL personnel, but it should be checked during recommissioning.

Heating Coils

The heating coil operational history has been previously reviews with SERL personnel, and has determined that only one coil (each cell has eight) was leaking. This one coil has been identified and should be isolated from service. SERL should monitor the leak status of the coils to verify that, by isolating the one leaking coil, there are no other leaks. Unless a new leak develops, it is suggested that no further action be taken for

interim operations. For long term operations, the leaking heating coil should be replaced.

Decant System

The process of removing the decant from the fuel cells should be upgraded to allow the decant to gravity flow from each cell via the existing decant ports to the existing trench. The decanted aqueous phase gravity flows from the trench into the sump at the west end of the fuel cell building. The aqueous phase is then pumped to the existing wastewater treatment system. Decanting should be accomplished with a floating decanter assembly and hose. The decanter assembly should prevent floating solids from entering the decant hose and should take suction from approximately 10.2 to 15.2 cm (4 to 6 in) beneath the top of the liquid. An isolation valve on the outlet from the decanter port will allow the fuel cell to be filled, and the solids to settle, before the aqueous phase is decanted. The sump and the transfer sump pump should be inspected during commissioning to verify proper operation. Any necessary maintenance or repairs to the pump should be made at that time.

Crane Air Supply

JWEL agrees with the Department of Labour's previous concerns about the pressurized air lines to the overhead crane cab. Unless repaired, the crane cab air conditioner will draw air from the interior of the fuel cell building into the crane cab. The air duct zipper is torn and must be repaired. SERL should repair the air duct prior to start-up of the fuel cell system.

Wastewater Treatment Plant

The interface of the existing wastewater treatment system with the feed preparation facility has been previously reviewed. The results of this review are summarized below.

Wastewater Throughput

Based on the anticipated approach to dewatering the sediments in the feed preparation facility located adjacent to the South Tar Pond, the existing wastewater treatment plant capacity is adequate to support the operation of the fluidized bed incineration facility.

Effluent Water Quality

It is not anticipated that running the wastewater treatment plant when the incinerators are not operating will be required. Hence, the installation of a vapour-phase carbon cell, which could be utilized whenever the wastewater treatment plant was running and the incinerators were down, is not required.

Baghouse

The problems experienced with the baghouse and ancillary equipment are typical for these types of processes. Therefore, based on an inspection of the equipment and discussions with previous operations personnel, it is recommended that the existing equipment requires only minor modifications for interim operations.

Baghouse Ash Fugitive Emissions

The baghouse ash pneumatic conveying system is a commonly used device to convey ash into the ash silo. Line pluggage can be minimized by resetting the timers in the programmable logic controller (PLC) so that ash does not remain in the transfer line.

Baghouse Air Compressor

A concrete pad should be installed adjacent to the south side of the baghouse, and a steel-framed, metal-clad enclosure erected. Electric heat/lighting should be provided to the enclosure. The air compressor should then be relocated into the new enclosure, and plumbing/power cables run from the existing air system and power source.

Pugmill Water Control

The pugmill is required to wet the ash for dust suppression. Moisture control is achieved by adjusting the water flow to the pugmill based on the dust flow rate. The water must be started automatically upon commencing ash flow into the pugmill, and stopped automatically once the ash flow has ceased. These changes should be made to the existing PLC during commissioning and start-up of the fluid bed system, since sophisticated moisture control instrumentation has not been cost-effective in improving on ash moisture systems.

North Side Baghouse Facilities

The pugmill and baghouse ancillary systems are currently located outdoors. SERL should design, supply, and erect steel-framed, metal-clad enclosures for the following equipment:

- Baghouse ash exhauster, lime/sand blowers, and the ash storage silo aeration blower.
- Pugmill area, complete with decking and spill clean-up trap doors in the decking.
- Lime, sand, and ash panels.

Erection of these enclosures with lighting to meet regulatory standards should ensure protection for personnel and equipment from inclement weather.

Ash Handling Systems

Ash will be collected at four locations within the fluid bed incineration system; the boiler, fluid bed bottom, the baghouse and the economizer hopper.

Boiler Ash

Boiler ash should be transferred from the wet drag flight conveyor onto a belt conveyor. This new conveyor should discharge the ash into a portable bin located just outside the boiler house. The new conveyor and portable bin should improve the general housekeeping in and around the boiler ash collection system, and

should reduce operator time and exposure to this ash stream.

Fluid Bed Ash

Previous operations personnel noted that at times it was necessary to reduce the solids in the bed (lower the bed level). This should be accomplished by reducing the air flow to the ash classifier, thereby increasing the solids that are removed in the classifier hopper.

Fluid bed ash will be both hot and dusty. The current method of handling these solids is to allow them to discharge onto the ground and then manually transfer them into a portable bin. SERL should modify this process to mechanically convey the solids to a portable bin. Two drag flight conveyors should be installed to move the bottom ash from the two fluid beds onto a common transfer conveyor (also a drag flight). The ash should then discharge from the transfer conveyor into a portable bin. All conveyors should be covered to eliminate fugitive emissions, to limit operator exposure to the hot, dusty material, and to greatly improve housekeeping in this highly visible area.

Turbine Generator and Condenser

A preliminary inspection of the turbine generator and condenser has been undertaken, and operations personnel interviewed on the condition and historical performance of this equipment. Based on this information, any work on this equipment will likely consist of normal preventative maintenance that would be undertaken prior to start-up of the equipment. To maximize the reliable operation of the turbine generator and condenser, SERL should perform the following:

- Remove the bearings for inspection of the shaft and bearing surfaces.
- Inspect the shaft coupling clearances.
- Check the turbine bearing elevations-the possibility exists that they could have changed due to operation of the generator.
- Resurface the rotor slip ring running surfaces.
- Sample, test, and clean (if required) the lube oil.
- Check the plugs and spindles of the emergency stop valves and the governor valves.
- Inspect the shaft glands.
- Clean the exciter commutator, undercut the segment insulation, and resurface the commutator brushes.
- Check the insulation quality between the No. 4 bearing and exciter pedestal and the sole plate; clean and repair as necessary.
- Open the condenser and inspect water boxes and tube sheets; clean and perform leak test on tubes.

Performance of the above tasks should improve the reliability and performance from this equipment.

Turbine Overhead Crane

The turbine generator cannot be serviced without the overhead crane. SERL should address the turbine generator safety concerns by bringing the crane and its operation into compliance with all applicable codes and standards. At a minimum, the activities associated with repairing the turbine crane should include:

- Review and revise, as necessary, the electrical drawings supplied either from SYSCO's files or an electrical consultant.
- Repair/replace the overhead lighting in the crane parking bay to bring it up to standards.
- Upgrade walkways and handrails; install warning signs, markings, and tags at appropriate locations.
- Develop and implement a lockout procedure for the crane.
- Inspect/repair the operator's cab, as necessary.
- Conduct general housekeeping (i.e., cleanup of oil/grease spills); locate the source of any spills and repair.
- Inspect/repair the crane in accordance with the crane manufacturer's recommendations.

Electrical and Instrumentation Systems

The electrical and instrumentation systems are integral to the successful operation of the incinerators. The following is recommended.

Uninterruptable Power Source (UPS)

Because the current UPS feeding the DCS is malfunctioning, SERL should design, specify, and install a new UPS for the existing incineration system. The new UPS should be in the 5-10 kVA range, and should supply all essential loads at 120V/240V. This should include DCS panel power supplies, the plant air compressor after-cooler fan, and the fire water booster pump.

Distributive Control System (DCS)

To improve reliability, SERL should recommission the Baily DCS by performing the following:

- Field test approximately 150 analog inputs/outputs (I/O) and 400 digital I/Os
- Functionally check each control loop and program logic.
- Simulate various operating conditions to check the process control logic.
- Confirm operation of control functions, shutdown functions, and emergency systems.
- Check all ancillary equipment and systems, including motors, variable speed drives (VSD), burner management systems, etc.

By performing the above tasks, SERL should be able to identify and correct problems/potential problems during the commissioning stage, thus eliminating potential downtime associated with the DCS.

Powerhouse and Harbour Pumphouse Lighting

To ensure operator safety and to achieve an acceptable standard of lighting, SERL should upgrade the lighting system and add new lights as required.

Coal Conveyor Control Panel

SERL should design, specify, and install components and cabling to the existing control panel for automatic control of the coal conveyor from the main control room DCS. The DCS control program should be modified to allow for control of the coal conveyor.

550-volt Switchgear and Package Boiler Instrumentation

The package boiler instrumentation should be cleaned and checked prior to and during commissioning and start-up of the fluidized bed incinerators. All motor controls in the ground-level MCC building and MCC No. 1 and MCC No. 2 on the boiler house control room levels should be cleaned and checked. Each motor starter should be cleaned and checked prior to start-up to ensure all are functioning properly. The package boiler instrumentation should be functionally tested to verify proper operation of all controls and instrumentation associated with the package boiler. Any controls, instrumentation, starters, and related equipment determined to be damaged or otherwise inoperable should be repaired/replaced as needed.

Oxygen Analyzers

The oxygen analyzers in the furnace exit ducts are considered standard O&M items and, like all other instruments associated with the existing incinerator equipment, should be inspected, cleaned, loop tested, and calibrated prior to commissioning.

Cooling Water Screens and Harbour Pumphouse

Due to the significant deterioration of the screen and assembly, and the downtime that would result from a failure of this system, it is recommended that SERL perform at least the following:

- Inspect all screens, links, rollers, gears, etc. and replace as needed.
- Employ the services of a diver to inspect the bottom screen guides and suction lines for possible problems.
- Inspect and test the drive train, and repair as needed.
- Reassemble and recommission the traveling screen.
- Replace or repair the existing vortex breaker plates.

Based on discussions with previous plant operations personnel, and the previous inspection, all other equipment in the harbour pumphouse were determined to be in good operating condition.

Powerhouse and Auxiliary Buildings

Because of the age and subsequent need for perpetual care of the powerhouse, it is recommended that operational personnel be assigned the reporting of problems and potential problems (i.e., leaks, potential structural problems, etc.).

The control room and instrumentation room in the powerhouse should be painted, paneled, and sealed. These cosmetic improvements should improve the overall work environment for operations personnel. Additionally, the air conditioning system should be checked and repaired/replaced as needed.

The decontamination building in the fuel cell area was previously inspected and determined to be functional. However, SERL should provide a general cleaning of the decontamination building and to install additional lockers. Access was not gained to the facility at the transfer station but, judging by the fuel cell decontamination facility, feels it is probably serviceable.

A local subcontractor should be placed on an annual blanket purchase order (based upon an estimate of material and labour) to keep the building in an acceptable state of repair. All operational areas and frequented walkways should be brought to regulatory standards prior to start-up of the fluidized bed incineration systems. This should include improvements to access ramps, walkways, handrails, etc.

Continuous Emissions Monitor

The CEM system was previously inspected and determined to be in good condition. However, the current CEM configuration requires the daily calibrations to be performed manually. This is substantially different than other CEM systems, where zero and span calibrations are automatically initiated and carried out by the control system. SERL should upgrade the fluid bed incinerator CEM system to allow for automatic daily calibrations.

The CEM data acquisition system (DAS) currently relies on manual data transfer to spreadsheets for data reporting. Therefore, the development of the CEM data reports is very labour intensive. SERL should modify the existing DAS to improve data logging and reporting. The DCS should be reprogrammed to retrieve, sort, and summarize the CEM data into the desired reports.

Also, the combined CO/SO_2 monitor should be commissioned and a relative accuracy test be performed during the compliance tests.

Other Modifications

JWEL-IT, in conjunction with consultants Nicholas Strum, P.Eng. and Hedley Smith, P.Eng., previously identified additional modifications that are recommended as essential for safe and successful operation of the fluidized bed incinerators and co-generation system. Each activity involves the design, procurement, installation, and commissioning of equipment.

It should be noted that in the past Environment Canada has required an enclosed disposal facility in the past. The previously used ash containment building no longer exists. It should be noted that in the past Environment Canada has required an enclosed disposal facility in the past. The previously used ash containment building no longer exists.

Transformer T1 failed and was replaced by a surplus transformer provided by Nova Scotia Power Incorporated. The arrangement with NSPI should be discussed and confirmed.

- Install turbine generator TG5 potential transformer secondary fusing in order to separate metering devices from protection relays in No. 3 Powerhouse - The need for secondary fusing on metering and protection circuits arises from the recognition that some minor deficiencies exist in the No. 3 Powerhouse protection, control, and metering circuitry. If separation of metering and protection circuitry is not carried out, failure of a component in metering circuitry can shut down TG5, thus causing a shutdown of the incineration plant.
- Calibrate and commission under voltage card for powerhouse 120V DC battery charger - This item identifies a component in the powerhouse 120V DC power system (plant control power) which was never commissioned due to late arrival of this component on site.

- Design/install harbour pumphouse alarm system which sends a group alarm to the plant DCS on existing instrument cable - At present, there is no form of communication with the remotely located harbour pumphouse, other than by foot patrolman using a portable FM radio. This item addresses the requirement to monitor the status of all of the important electrical apparatuses in the pumphouse, and to marshall the field inputs in a local annunciator, which will then send a general alarm to the existing plant DCS by way of a communication cable interconnecting these two locations.

- Install new high-level sensor in the decant water treatment plant raw water compartment and modify existing PLC logic in BCA control panel to de-energize the feed pumps when the compartment is flooding. - The need for a high-level sensor in the BCA water treatment system of the decant water treatment plant was identified during prior operations of the water treatment system. This was a packaged system, designed and supplied by an equipment manufacturer. The sensor can be incorporated at a modest cost.

- Modify the grounding and shielding of instrument cables. - Based on site inspections carried out in 1994, it appears that some cable shields are incorrectly installed. SERL should assure that the overall instrument cable shield grounding system are inspected and corrected where required.

- Review and repair any diesel air compressor automatic controls which are not working. - The diesel air compressor is a backup to the existing incineration plant air compressor. This was a used unit brought on site and modified to start automatically on loss of manifold air pressure. The automatic start controls have suffered a component failure; therefore, these controls require some remedial repairs.

- Control room lamps and sockets on speeder gear controls require replacement. - The TG5 speeder motor controls, used for loading of the generator, are located in the control room adjacent to the DCS control desk. The indicating lamps and sockets for indication of increasing/decreasing load have failed several times. The cause has been identified as high voltage transient conditions caused by pulsing of the speeder motor. The solution is to replace the sockets and lamps and to provide voltage clipping protection on the speeder motor circuit.

- Repair/replace remote ammeter and ammeter mounting box located at the main cooling water pump at the harbour pumphouse. - The harbour pumphouse cooling water pump motor was provided with a remote ammeter, located adjacent to the motor, which provides the operator with some indication of motor operating conditions. This ammeter and enclosure are damaged; therefore, replacement is required.

- Recommission the item identified as 86/G5, an essential tripping lockout relay, important to the generator protection scheme.

- Resolve problem with No. 3 Powerhouse and intertie substation 6.9kv feeder and 25kv system ground fault protection equipment (shielding of Westinghouse GFI relay is not adequate; the existing relays are unacceptable). - There is a problem with approximately 12 of the powerhouse 6.9kv feeder ground fault protective relays. False operation of these relays is possible if a portable FM radio is transmitting close by. The relays are improperly shielded against such conditions. Replacement relays must be identified and installed.

- Investigate and eliminate circulating ground currents in pipes around bleeder 83 buswork-(with G5 at full load). - Spurious circulating current caused by magnetic coupling between supporting

pipework in the powerhouse and the phase current of the generator output busses was previously identified. The seriousness of this coupling at generator maximum output has not been determined. This issue must be investigated by measuring the maximum circulating current and eliminating circulating paths, if necessary.

- Install transformer oil temperature indicators for transformer T2. - Replace silica gel breathers on transformer and T2.

- Repair oil leaks in transformer T2.

- Supply and install a silica gel breather and piping connection system on transformer T3. (Powerhouse 2300v station service).

- Replace silica gel breather on transformer T15. - This requires full access to transformer T15 (outage to intertie substation required).

- Repair oil leaks in A/B transformer 600 kVa.

- Upgrade main harbour pumphouse cooling water pump motor protection by installing a multiline, multifunction motor protection relay to replace the existing overload block. - The addition of a multifunction motor protection relay to protect the 800HP cooling water pump motor is considered standard engineering practice for a motor of this horsepower and importance to the operation.

- Perform necessary structural repairs to 25kv-6.9kv substation. - In 1992, the structural frame which supports the 23kv bus and disconnect switches outside the No. 3 Powerhouse was assessed in structural terms, and was found to be in need of repairs. The remedial work needed was identified in an assessment report prepared by the consulting firm Beasy Nicoll Engineering Limited.

- Modify the intertie substation 25kv circuit breaker 165 trip coil monitor relay wiring. - This work requires full access to breaker 165 (outage of intertie substation required). The tripping circuit of the 25kv circuit breakers installed in the existing power distribution system is provided with circuits which monitor the integrity of trip coils. Alarm contacts are provided to local annunciators to warn of failed trip coils. The monitoring circuit in the circuit breaker identified as Breaker 165, located at the intertie substation, has demonstrated incorrect operation. A previous site inspection indicated that wiring modifications are required.

- Remove obsolete 2300v cables between the wall-mounted disconnect switches and the 2300v metal-clad switchgear at the harbour pumphouse. - There is a need to dismantle some obsolete electrical

apparatus in the harbour pumphouse. The apparatus in question is presently de-energized, but is located in close proximity to live, open bus-type equipment which is required to continue in operation. This is an important safety-related issue.

- Upgrade fuel cell building trace heating of emergency shower facilities for Class I Div 2 area. - The emergency shower facility located in the fuel cell building was provided with electric trace heating of water lines for year-round operation. The trace heating supplied by the equipment manufacturer does not meet the electrical classification requirements of the space in which the shower facility is installed. Replacement of the tracer with one of correct classification is required.

- Carry out full infrared thermographic survey of electrical distribution equipment throughout the electrical power distribution and generation system. - An infrared thermographic survey of all electrical apparatus under maximum load conditions should be a standard routine maintenance requirement throughout the life of operations. It is also standard practice in all new heavy industries to carry out such a survey after full or maximum load conditions have been achieved for the first time.

- Inspect and test overcurrent and generator protection relays for powerhouse 2300v and 6900v feeders. - Electrical system protective relays and critical control circuits are tested on a routine basis to ensure the operating integrity of the important system components. Protective relays are installed in the powerhouse, boilerhouse, harbour pumphouse, and intertie substation. These devices are usually tested on a 2- or 3-year cycle. Since they were last known to be tested in 1992, they should be retested by SERL.

- Prepare as-built schematics and wiring diagrams for all equipment in use at harbour pumphouse. - The documentation of electrical equipment in the harbour pumphouse is inadequate. There is a need to prepare schematics, layouts, and wiring diagrams for power, control, and instruments. This kind of information will be necessary if electrical maintenance is to be carried out in an effective manner.

- Design and install a steel-reinforced slab capable of supporting a 40-tonne load on two truck axles. - The slab should extend from the boilerhouse to the turbo-blowerhouse wall, and from the north wall of the boilerhouse annex to the south edge of the incinerator slab. This should create a surface on which to place a lugger box for efficient pickup of ash, and will upgrade the general housekeeping in the area.

- Procure and install steam unit heaters, piping, drains, and a condensate return system from the unit heaters in all equipment enclosures and additional unit heaters in the powerhouse. - At present, most of the equipment enclosures are heated by electric heater units drawing 10kw of electrical power each. In most cases, at least two heaters per enclosure are required. During the winter, the package

boiler must be operated to provide freeze protection for "C" boiler. It operates at 10 to 25 percen of the boiler capacity, which is not an efficient loading on this boiler. Using steam unit heaters would increase the load/efficiency of the package boiler, and each steam unit heater would eliminate two o more electrical heaters, thereby reducing the plant electrical load and resulting in reduced operating costs.